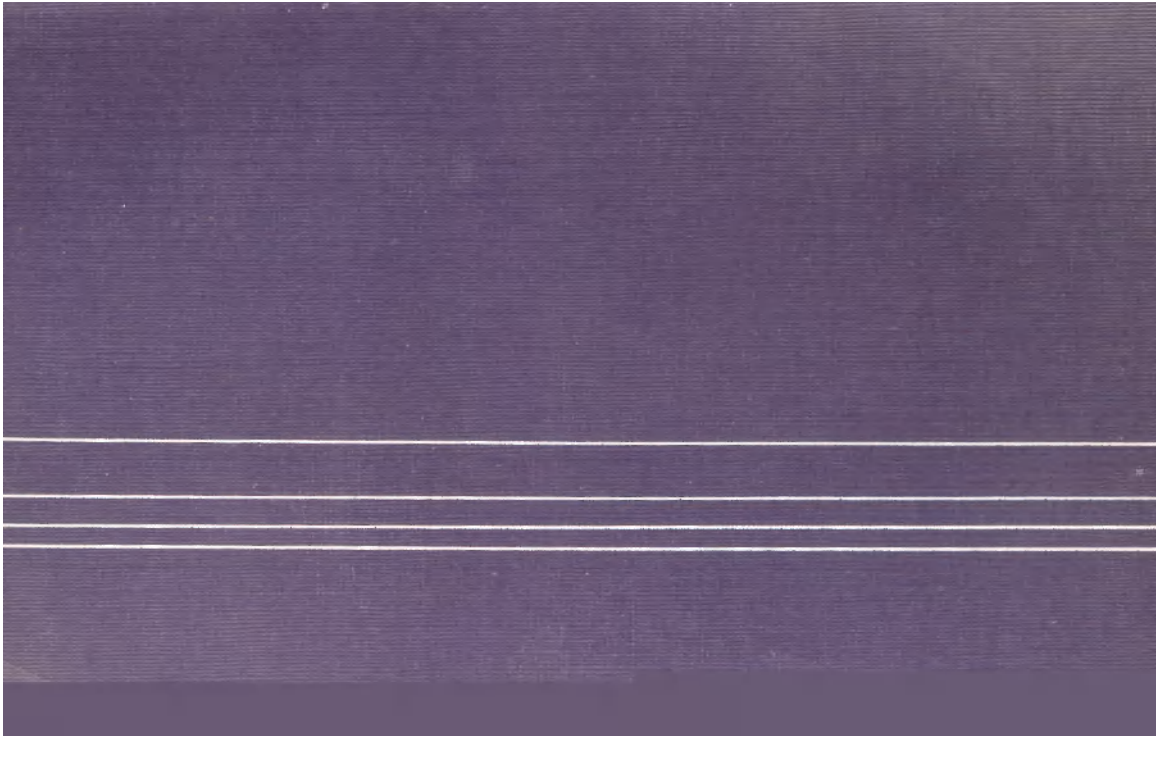
Pioneers of Space



Pioneers of Space

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The bus brought us to the base of the rocket. In just a few minutes, Yuri Gagarin would take his place inside. He said goodbye to the members of the State Commission, scientists and fellow-cosmonauts. We were both in spacesuits, but we embraced, touching helmets.

"Dear friends, known and unknown to me!" Gagarin greeted those who had come to see him off. "In a few minutes this powerful spaceship will carry me into the vastness of the universe. Let me say this before I go. My entire life up until now seems but one glorious moment. Everything that I experienced and accomplished in the past was for the sake of this journey. All of you no doubt understand how difficult it is for me to gather my thoughts now that the moment has arrived to test that which we have worked so long and hard to achieve..."

Yuri sounded proud and excited. He was going up, not I (I was what they now call the back-up). But the words of my friend, who was honoured by being chosen to be the first, seemed to echo my own feelings.

"And if I am still determined to make this flight," Gagarin went on, "it is because I am a Communist, because I am following the example of the dauntless

heroism of my compatriots—the Soviet people. I know that I will gather all my willpower to fulfil my task to the best of my ability. I understand the importance of this task and will do everything possible to carry out the mission that the Communist Party and Soviet people have given me."

We did not doubt that Yuri meant what he said.

An elevator raised Gagarin up to the spaceship hatch. Before he entered, he raised his arm once again.

"See you soon!" And Gagarin disappeared inside the cabin. The hatch slammed shut, and we remained, transfixed, at the base of the rocket.

When Yuri reported, "I'm well and ready," I returned to the bus and quickly changed out of my spacesuit into my "earth clothes". I joined my fellow-cosmonauts at the communications centre where we listened to the radio exchange between Yuri and mission control as the rocket was prepared for launch. Gagarin's voice sounded strong over the speaker:

"I feel great. I'm doing as they taught me."

We all grinned: if a cosmonaut could joke, he must really feel great.

A tense half hour or more passed before the final command rang out over the steppe:

"Lift-off!"

The first time in the world that a manned spaceship was being launched into space.

The engines roared and the base of the rocket was enveloped in clouds of smoke. With each passing second the noise of the engines increased and the billows of smoke grew thicker and larger. Soon the lower half of the rocket was hidden in the smoke while a sea of fire raged below. The rocket shook slightly and then slowly began to lift upward. Happy journey, my friend!

People often ask me: "What did you feel when Gagarin went up?"

My feelings and thoughts were those of a pilot who watches his comrade test a new plane. The friends who remain on the ground carefully observe the actions of the pilot, analyze them and draw conclusions. That is what I did. During the immediate preparations for lift-off, I was busy with technical matters, and followed the issue of commands and reports made by Gagarin. When the rocket lifted off the launch pad and flew upward, I watched the barely perceptible quivering of the rocket vehicle and was thus able to judge the functioning of the jet vanes, which guide the rocket along its trajectory.

As the rocket sped upward, the roar of its engines grew faint. The cosmodrome seemed empty. It had happened so many times before—I would be standing and talking to a comrade on the airfield, and the next minute he would be far away. What was happening to him now? What would the next few minutes bring? Every pilot has experienced this feeling of uneasiness at the beginning of a flight.

The time was approaching when the rocket was to break through the earth's atmosphere and then eject its nose cone. We were all concerned about the automatic ejection. Finally, Gagarin reported:

"Nose cone ejected. I see the Earth!"

"It worked!" We were all elated.

As the rocket consumed fuel and gathered speed, the stages separated one after another. Yuri briefly informed us that the rocket had entered orbit and there was no gravity. All our attention was focused on the cosmonaut's transmissions from space. How was he feeling? Was he taking weightlessness well?

I had read a lot about weightlessness and tried to imagine the condition. As a fighter pilot, I knew

something about it. At certain moments during flight, for example, when the plane is sort of "suspended", the pilot is weightless, and we had experienced short periods of weightlessness in our space training. Still ... it seemed fascinating.

On earth, man constantly feels the pull of gravity. Our organisms develop under this condition and we adapt to it: our hearts pump a certain amount of blood, we orient ourselves in space, determine what is up and what is down and move about in a normal fashion. But what would it be like under conditions of weightlessness, when there is no gravity?

In his science fiction book *Dreams of Earth and Sky*, Konstantin Tsiolkovsky described the condition of weightlessness:

"I floated around the room, from the ceiling to the floor and back again. I turned somersaults like a clown, in spite of myself bumping into objects and tangling up my arms and legs. Everything I hit was set in motion. I felt I was constantly falling... Water spilled out of a jug and floated in the shape of a vibrating sphere. Then it broke into droplets and began to slide down the walls... Under such conditions a stationary body will remain motionless unless it is acted upon by a force, and a body in motion will move forever."

That was an imaginative description. But what would it really be like?

Gagarin reported from space: "The flight is proceeding smoothly. I feel fine. All instruments and all systems are operating normally."

He was carrying out the mission, so the lack of gravity was apparently not bothering him.

Gagarin's flight was useful in testing the extremely important automatic systems which controlled the flight of the rocket and the functioning of all its complex mechanisms and equipment. The rocket's

plotted trajectory, the operation of its engines, ejection of stages and its descent were all controlled automatically, as were life support systems inside. We were very happy to learn that all the automatic systems were functioning.

Then, no one was able to ponder the significance of the first manned space flight. There simply wasn't time.

"Let's ride to the plane," Nikolai Kamanin suggested. "We'll fly to the landing point."

The plane took off and gained altitude. We all listened attentively to the radio transmissions coming over a speaker in the cabin. Only those who had been training for such a flight themselves could understand the detailed bits of information coming from space.

Gagarin reported:

"This is a routine report. It is 9.48. The orbit correct. I feel fine."

He continued to make reports:

"I am switching to solar orientation..." "The flight is proceeding normally. I am now over America..." "I see the earth's horizon. It's a beautiful halo. It's like a rainbow close to the earth surface. Beautiful..."

Still ahead was the final, perhaps most important and, in all probability, most difficult stage of the flight—the reentry and landing. Would everything work according to plan? Although the deceleration and landing systems had been checked often in space flights with animals, there was always a possibility that something unexpected might happen. Would Yuri be able to land using manual controls? I thought back to our joint training exercises... "Everything will be fine," I assured myself. At 10.55 the *Vostok* spaceship landed successfully in the designated area. Gagarin reported: "Please inform the Party and Gov-

ernment that the landing was normal. I feel fine and am uninjured."

The first manned space flight had been a success!

We arrived at the landing area, and I ran to embrace Yuri. He was surrounded by people, but I began to squeeze my way through the crowd. People looked at me in surprise and irritation, but I continued to make my way forward. Yuri noticed me when I was just a few feet away and rushed toward me. We hugged each other for a long time.

Later, at a rest resort, Yuri and I walked along the shore of the Volga. The snow was melting, the ground becoming dry and firm. Here and there patches of bright green grass had sprouted, and fragrant leaves were budding on the trees. Dark-red catkins draped the alders. The mighty Volga River had begun to thaw, and chunks of ice were being swept along by the murky water. In the tree branches, rooks were busy repairing their old nests, starlings flew to and fro. It was an enchanting scene—a unique hymn to spring.

This charming panorama of the awakening of Russian nature pleasantly harmonized with our good spirits. Yuri shared his impressions with me, and we both thought about future flights.

Suddenly, Yuri grew silent and stared at the sky.

"What's the matter?" I asked. "Are you thinking about the time when we might be walking along the shore of a Martian river, admiring the setting sun and Earth?"

"That would really be something!" he laughed.

Later there was that unforgettable day in Moscow. Yuri stood together with Party and Government leaders on the platform of the Lenin Mausoleum. Red Square was filed with ebullient, happy throngs of people. I and the other cosmonauts walked among the files of demonstrators. We were yelling, clapping

and laughing. Yuri noticed us and waved. Voices rang out above the Square: "Glory to the Party! Gagarin!"

That same time the radio proclaimed the wonderful news: Yuri Gagarin had been named a Hero of the Soviet Union.

The Presidium of the Supreme Soviet of the USSR distinguished many of the specialists who had participated in the launch programme with awards. We—the first detachment of cosmonauts (later we came to be known as the Gagarin group)—were also given awards. I received the Order of Lenin.

Now, when I think back on the time, I have a clearer understanding of the profound significance of those events and the role played by Gagarin. It would be no exaggeration to say that after that day—April 12, 1961—the day which came to be known around the globe as the Dawn of the Space Age, no other man was so admired, not only in his own country but throughout the world.

To the cosmonauts, Yuri was a colleague, to many of them—a dear friend. He was an ordinary guy who had travelled a difficult road before he was able to reach for the stars. Thousands of young people in our country are travelling similar roads and following their dreams.

That it took one hundred and eight minutes to circle our planet testifies to the speed of the *Vostok* spaceship. But these weren't just ordinary minutes, they were minutes in space. And that is why they shook the world. It is not only the historians who will remember this time. Our great-grandchildren and distant posterity will read and study about the birth of a new era, how a trail to the endless universe was blazed by the children of the Earth.

The achievement of the Soviet people was heralded in newspapers around the world: "Major Gagarin

and his *Vostok* spacecraft will go down in history", "Man's most remarkable achievement", "Hats off to the Russians". And it was only natural that when Yuri's space flight was over, he should begin his "earth" travels: the whole world wanted to see the first cosmonaut in space.

Gagarin read speeches at assemblies and meetings, spoke in factory shops and laboratories, appeared before schoolchildren and university students, and gave interviews to numerous journalists. He was an excellent speaker, as was evidenced by the avid attention of his audiences and their rousing applause.

Gagarin visited many countries around the world. Still, his heavy social and political duties never distracted him from what had become his passion in life. Yuri was excited by each new launch and wanted to participate in the missions. But we knew that deep in his heart he was sad and envied us, for each flight was more interesting than the last. As a professional pilot, it was difficult for him to be on the sidelines, though he continued to share his knowledge and enthusiasm during preparations for each new mission. He was present whenever a cosmonaut went into space, sharing the experience with him; he taught others while he learned himself. He dreamed of the time when our spacecraft would travel to the planets, when he himself would once again command a rocket ship.

It was for this dream that Yuri Gagarin went into space, it was for this reason that he worked and lived.

After reading through my personal records, once again the memory of that time rushes to my mind. In looking through my cherished collection of photographs, souvenirs and mementos, I recall the many events, meetings, interesting discussions and large and small endeavors which I witnessed or played a direct role in more than twenty years ago.

My recollections are those of the beginning—of the selection and training of the first cosmonauts and the special nature of our work. I write them down for those who wish to learn more about the start of our manned space programme. As with everything in the past, the details of this beginning can be reconstructed with the help of those people fortunate enough to participate in the programme. I suggest that we take as our starting point the late fifties and early sixties of our turbulent twentieth century.

Each participant in the manned space programme was, in my opinion, a highly motivated and responsible individual. Skilled specialists predicted a propitious fate for the newly-created programme, which would rely on the significant contributions of Soviet science, the rocket industry and aviation.

The majority of specialists selected for the new

programme were young people who brought with them all the advantages of youth. The older specialists were, as always, more knowledgeable, cautious, thorough and experienced—exactly those characteristics that the young "hot-heads" sometimes lacked. But then the "oldsters" had to hand it to the young when it came to daring and endurance.

Soon no one was bothered by the overwhelming questions and problems or the grave responsibilities that accompanied those first steps into a new, untested sphere. The numerous difficulties and daily exasperations did not dishearten anyone, they only served to double and triple the scientists' endeavors and to rally their efforts. The prevailing spirit of enthusiasm was what helped overcome complicated and often dangerous tasks in an incredibly short period of time. And this spirit was shared not by a few fanatics but by the many thousands of Soviet specialists and workers who were called upon to usher in the dawn of the space age—to begin what Konstantin Tsiolkovsky had predicted would be the era of starflight.

No one thought the job of selecting and training men for a trip into space would be easy. I recall how years before technological preparations for a manned space flight around the earth had even begun (preparations which included protection devices against the harmful effects of space, life support systems, and the safe landing of the pilot even under emergency situations) the Academy of Sciences began to receive what many considered at the time to be rather curious letters. The people who wrote them all firmly believed that the Soviet Union had earned the right and that it was therefore the country's duty to send the first man into space. They volunteered themselves for the first flight, the sincerity of their wishes reflected by their ardent courage: many

were willing to be sent only "up" (one way) in order to transmit information to earth. For the sake of human progress and a better life, they would sacrifice themselves to science.

Such patriotism is worthy of admiration. But it was not just a pioneer we needed to open this new sphere of human endeavour. We would have to construct a spacecraft that would function reliably from lift-off to landing, to develop a rational and effective method of selecting and training spacemen.

Everyone involved in the programme was immediately concerned with the task of selecting and training the first group of Soviet spacemen. We received many suggestions, and not only from specialists and those directly involved in the programme. Our discussions were not so much concerned with "what" and "how" as the fundamental aspect of the mission and its drawbacks. By the summer of 1959 the battle of words had quieted down. Instead of indulging in intuitive searches, we began the real work, which always leads to needed solutions. During a routine meeting of the Academy of Sciences it was decided to begin to subject a group of prospective cosmonauts to medical screening. Training for the flight was to begin no later than spring 1960.

As an aviation doctor and researcher specializing in pilot recruitment, physical fitness training and safety, I was asked early in 1959 to conduct similar work for the manned space programme. After the basic technical problems of space flight had been solved, our attention turned to new questions—those of a medical and biological nature. We needed to know answers to many important questions: Can the human organism withstand such an undertaking? What technology is needed? What risks does the pilot face? What specific traits must the selected cosmonaut possess? What is the best way to train the pilot

when so much about space remains a mystery? These and numerous other "hows" and "whats" were to be considered by the medical and biological specialists. To be sure, we were unable to answer the majority of questions initially. No one could know for certain what might happen to a man during the flight. The first spacefarer would have to learn much for himself. But despite the uncertainty, the specialists, particularly the aviation doctors, were obliged to do everything possible to ensure the successful outcome of this enormously important and risky venture.

It seems unlikely today that anything should have gone wrong with the first manned space flight. Nonetheless, scientists then acknowledged that the mission might prove impossible due to the human organism's frailty. We did not know enough at that time to be overly optimistic. Still experiments conducted by Soviet scientists with dogs and other animals aboard rockets and the second artificial earth satellite gave us reason to hope for the best. But the data collected from these experiments told us nothing of how space would affect the human organism and psychology.

An unsuccessful mission might, first of all, cost the life of the first man in space. Secondly, it would considerably delay man's direct space exploration. Much time would be spent in trying to determine if the cause of failure was due to a technical flaw or man's biological weakness.

American newspapers and magazines were reporting that of 510 test pilots who had volunteered for the space programme, Air Force doctors had in the end selected seven. They were all in excellent physical condition and had the necessary professional background for the programme: a degree in engineering and no less than 3,000 flight hours, half of which

were logged in jets. The American astronauts were between 35 and 40 years old.

American scientists did not consider it necessary to create a permanent training base for the "Phenomenal Seven". Instead, they used facilities provided by scientific research institutes, centres and laboratories, hospitals, clinics and companies involved in space technology. As part of their training programme, the astronauts were to help design the *Mercury* spacecraft and the *Atlas* booster as well as follow a ballistic trajectory in a manned, suborbital flight.

Soviet scientists, particularly Academician Sergei Korolev, the chief designer of the space rocket system, thought differently. They wanted young, strong and daring cosmonauts, and experience was of secondary importance. These men would be chosen from among fighter pilots whose professional skills were acknowledged to be closest to those that would be required of space pioneers.

"A fighter pilot is a versatile man," remarked Korolev. "Difficult and risky missions are his job."

Korolev recommended using three equally important criteria to select the best fighter pilots: first, the ability to carry out precisely programmed functions (which we will refer to as reliable professional skill); second, an aptitude for research which would be necessary to help develop rocket technology (to be called creative potential), and third, excellent health and the ability to withstand physical and psychological pressures ("healthy as a horse" and having "nerves of steel"), in other words, the candidate should have the psycho-physiological characteristics that would make it possible to train him to fulfil a difficult mission.

In accordance with Korolev's instructions, during the first few rocket flights the cosmonauts would perform only a limited number of tasks, such as self-

monitoring, general flight observation, operating technical equipment, evaluating the functioning of automatic systems at each stage of the flight, and, should automation fail, using the technical equipment to bring the rocket out of orbit.

Korolev was personally involved in deciding which qualities were important for all future cosmonauts. And he came up with his own "technical parameters", as he called them: inquisitiveness, industriousness, and ardent enthusiasm for the space programme. He instructed the aviation doctors who were sent to the air force units in summer 1959 to select men between 25 and 30 years of age who were no taller than 170-175 cm and weighed no more than 70-72 kg.

The Chief Designer was especially insistent about the latter two "technical" requirements, explaining that a smaller cosmonaut would allow more room for instruments (recorders) to register the parameters of the flight. Korolev was certainly a cautious designer: the rocket itself weighed more than 4.5 tonnes!

As for the age of the future cosmonauts, Korolev had this to say: "As has been repeatedly demonstrated in our automated flights and those with animals on board, our technology is such that we do not require, as the American Mercury project does, that our early cosmonauts to be highly skilled engineers. The American astronauts must help control the rocket systems at every phase of the flight." Korolev was openly proud of the technical advantages of the *Vostok*. "The first cosmonauts," he explained, "must be daring young men who have a great future in space, whose entire working lives still lie ahead. Lack of experience and knowledge in flight testing is something that young enthusiasts can quickly make up for." At the request of the Soviet Air Command, aviation doctors personally interviewed a large

number of fighter pilots. Of these, approximately one hundred and fifty were summoned for further, more complete medical testing at the Moscow Aviation Hospital, and one hundred men were tested.

After two phases of testing, which took from four to six weeks, one out of five of these pilots was declared physically fit for space flight training. Thus, twenty men were among the first detachment of trainees at the Cosmonaut Training Centre.

A short while earlier, in August 1959, when the future cosmonauts were still undergoing medical and physical endurance testing at the Aviation Hospital, a large tract of land in a forest-park zone was apportioned for the construction of Zvezdny (Star) City (at that time it was simply known as Zeleny (Green) City). I was asked to take control of the territory and begin the construction design work.

I worked with the Cosmonaut Training Centre from 1959 until the end of 1963. A group of scientists gathered in Star City to work out the initial training programme for the first recruitment of cosmonauts—the Vanguard Six—who successfully completed the *Vostok* space flight missions. Building facilities and communications were constructed on the territory and two high-rise apartment complexes went up in the city's future residential sector.

But the first group of cosmonauts did not begin their training in Star City. Already by March 14, 1960, the future cosmonauts were undergoing training in two old converted buildings located on the territory of the Frunze Airport on Leningradsky Prospekt in Moscow. The trainees were twenty young, exuberant, healthy pilots filled with optimism and enthusiasm. The instructors were specialists from numerous scientific research institutes and the design bureau which had developed space technology. Some of these instructors quickly formed the core of

the team of specialists assigned to the Cosmonaut Training Centre. The first phase of the training programme required carrying out both traditional aviation exercises as well as principally new and original operations.

It was decided to regularly conduct physical training and conditioning exercises, simulate flights and hold medical examinations before and after various tests and training operations. Sometimes once, sometimes frequently, the future cosmonauts were asked to parachute jump, spend time in compression, temperature and isolation chambers, and be ejected (on land) from a plane, they were tested for equilibrium, spun around in a centrifuge and flew specially equipped aircraft capable of inducing weightlessness for a short period. On top of all this, the trainees attended a number of special courses (for the most part devoted to theory) and visited industrial and scientific research organizations. This will give some idea of what the first Cosmonaut Training Programme was like.

Most of the trainees immediately understood what was required of them. Despite the difficulties, they patiently and persistently did whatever was necessary for the new programme. Those first few months revealed differences among the men, who adjusted to their new regimen in various ways. Not all of the twenty selected for that first training programme successfully completed training.

The first Cosmonaut Training Programme was extremely flexible. We had to quickly adjust to unexpected circumstances and conditions. In addition to their usual functions, many of the organizations assisting us began to help train the cosmonauts as well. The programme had to be restructured for this, and much time was spent on frequent and long trips moving the trainees from one location to another.

The future cosmonauts were especially interested in astronomy and rocket technology. As pilots, they intuitively felt that their new profession was based on this theory. It is worth noting that the specialists who instructed the trainees were well-informed with the latest developments in rocket construction and the ideas of Chief Designer S. P. Korolev.

Without going into detail, I would like to mention that those first four months in Moscow at the Cosmonaut Training Centre were characterized by strict rules and regulations and an emphasis on academics. The daily intensive physical fitness and sport programme was not initially popular and only late did it begin helping the men to comprehend the complicated theoretical material they were being taught.

Certainly the specialists at the Centre had more than their share of difficulties, most of which were due to the acute lack of space, equipment and instruments. Certain instruments and devices had not yet even been invented at that time or were not easily portable.

By summer 1960, our staff and as yet modest supply of equipment had moved to the permanent training base in Star City. Some work facilities were already operational, and apartments were ready for the married cosmonauts and their families. The five bachelors among the trainees were moved into a comfortable dormitory, which was actually a three-room apartment. Apartments were also made available to the families of the programme directors.

It was gradually decided to divide the training programme into different stages. The initial training had been devoted to general programme orientation. Now the future cosmonauts would learn the specific skills needed for space flight.

It was not considered expedient to put all the

trainees through a single programme. Instead, five or six men were to be selected for the *Vostok* missions, while the others would take part in subsequent space flights. Thus the future cosmonauts were divided into groups before they had finished their initial training. Beginning in the summer of 1960, the group of cosmonauts including Gagarin, Titov, Nikolayev and Popovich began intensive training for the *Vostok* rocket missions.

Many organizations greatly assisted the Centre at its new location in Star City. Academician Korolev was especially interested in the Centre's work and gave the future cosmonauts his personal attention.

Chief Designer Sergei Pavlovich Korolev was even then a living legend. I first saw him in early 1959 at a meeting held at the USSR Academy of Sciences. I was immediately impressed by his intelligence, determination and insight, and our acquaintanceship over the next seven years, both on the job and away from it, would only strengthen my initial impression. I consider myself most fortunate to have had the opportunity to work with Korolev.

Sergei Pavlovich met the first detachment of cosmonauts in summer 1960 at an enterprise where he was directing work on the first spaceship. Korolev frequently visited Star City, listened to the requests and comments of the cosmonauts and programme directors at the Centre and tried to assist and support them in every way possible.

Hero of the Soviet Union and Lieutenant-General of Aviation Nikolai Kamanin, who became director of the Cosmonaut Training Programme the summer of 1960, together with his deputy, Hero of the Soviet Union L. I. Goreglyad, did a wonderful job in organizing the introductory training and preflight testing of the first group of future cosmonauts at the Cosmo-

naut Training Centre. A great debt is owed to the leading specialists at the Centre who worked directly with the cosmonauts. It was thanks to them that the entire training programme was completed at the Centre and other bases.

The medical and biological programme was extremely important and in some respects risky. There were two tasks: first, to uncover and develop to the maximum the psychological and physical traits of each cosmonaut in order to ensure his optimal performance during space flight, and second, to recommend which trainees were best prepared for the first and second flights.

Scientific researchers helped to create laboratory conditions to give the trainees an idea of how space flight would affect the human organism. Thus the cosmonauts would not experience the alarm each individual feels when confronted with the unknown. This was the only way that each trainee could be prepared for the weightlessness of space and its attendant effects.

The cosmonaut trainees selected for the first mission were by no means meek and docile. On the contrary, they were daring, determined and spirited. But the extraordinary conditions of space flight, the cosmonaut's heightened awareness of everything taking place around him, the exhausting waiting for each different phase of the flight, and, finally, the constant threat of the unexpected—all these things would put psychological pressure on even the most experienced pilot.

I recall the three most unlikable medical-biological procedures: standard medical examinations given almost daily before and after each test; repeated testing for temperature tolerance; and the unpleasant, to say the least, equilibrium testing in a rotating seat. It took a lot of talk and effort for the in-

structors to convince some of the overtaxed trainees of the need to prepare their bodies for space flight this way.

But of course it was necessary to conduct regular tests to discover how the body reacted to different demands. Only by means of a living galvanometer, the trainee himself, could scientists correctly limit the demands placed on the organism. In this way the scientists could give specific recommendations based on the individual abilities of each cosmonaut and draw up distinctive plans and programmes to help the men make the most of these abilities.

Highly skilled pilots gave the future cosmonauts flight and parachute training. Flying and jumping from planes were included in the training programme primarily because these two skills reliably test each and every psychological and physical aptitude of the human organism. For more than fifty years pilots have been improving their professional skills and raising their level of emotional self-control and physical coordination by such training.

We observed that whereas the trainees preferred flying training planes and specially equipped aircraft to all their other activities (understandable since they were all pilots), parachuting was a different matter altogether. It took considerable time and much persuasion on the part of the programme directors, and also the personal example of masters of sport in parachuting, to change the trainees' attitude toward parachute jumping. But gradually their interest grew, and they came to love jumping so much it was hard to tear them away from their parachutes.

Each time the trainees jumped (up to fifty times, including free-falls, night and water jumps), they gained strength and increased their courage and optimism. Also, they learned a survival skill necessary for every pilot, so well in fact that each trainee

earned the title of parachute instructor.

When the Vanguard Six had completed both their theoretical and practical training, we were faced with an unusual situation. Future pilots are of course trained to fly in real airplanes. To start with the plane remains on the ground. Then, in the air, the flight instructor gradually transfers control to the trainee. In our case however, we did not have a spaceship for training: it had only just been constructed. Nor, unfortunately, did we have a mock-up that could simulate the control system of the spacecraft.

Korolev suggested an alternative. Together with the director of one of the organizations which was working to equip the pilot cabin of the *Vostok*, the Chief Designer decided to construct simulation facilities using a model that had already been built. Certain aspects of the flight (motion of the globe beneath, the crossing of the terminator, etc.) could be recreated by the same group of engineers which had developed, tested and installed the ship's system of manual control.

The training programme on the space flight simulator was largely based on the experience of teaching pilot trainees. In comparing the training methodology at that time, which could be typed on two pages, with the complexities and scope of that which exists today, one nevertheless finds that the principles have remained the same. Just as before, the emphasis is on repeating ("replaying") each exercise from start to finish, both under normal flight conditions and in any conceivable kind of emergency situation.

The complete automation of the *Vostok* spacecraft was a topic much discussed at the time the training programme for the space flight simulator was being developed. Certain scientists who worried about placing too much psychological stress on the cosmonaut did not think it necessary to spend a lot

of time in training the first cosmonauts for manual reentry. But the experience of pilots, particularly test pilots, has shown how important it is to consider beforehand all possible complications that might arise and how they should be dealt with. Since nothing is one hundred per cent reliable and sooner or later even the most dependable automatic device will malfunction, it was necessary to devise an alternative (back-up) system of control.

Later, after our first "pupils"—Yuri Gagarin and Gherman Titov—had already flown in space, we at the Centre came up with a useful rule of thumb for both trainees and instructors: "By the time the spacecraft is ready for lift-off, the cosmonaut must be capable of accomplishing a much more complex and difficult mission than that which he has been assigned." Such advice will always be appropriate. Though spacecraft are constantly being improved and made more reliable, the number of emergency situations which pilots and cosmonauts must necessarily train for continues to rise. And this is not surprising considering the complexity of today's technology. As a matter of fact, it wasn't long before manual controls were needed for reentry. This occurred during the *Voskhod-2* mission. Cosmonauts Pavel Belyaev and Aleksei Leonov were not instructed to use the manual controls to bring down the rocket. However, when the automatic reentry system failed, the cosmonauts, who were prepared for just such an emergency, successfully flew the spacecraft during the final stage of the flight.

Now that cosmonauts are trained on highly realistic simulators by dozens of skilled instructors, some of whom have flown in space, it is interesting to recall how it all started.

Our training programme emphasized everything that could improve the physical fitness and condi-

tioning of the future cosmonauts. Each morning, year-round, regardless of the weather, they exercised for half an hour, took cold showers, worked out on gymnastic and specialized equipment and participated in sports competitions—all for their health.

Not all the trainees eagerly adapted to this rather intense exercise programme. At any rate, at least half of them lost their enthusiasm after the first couple of weeks. Soon the men were complaining about their heavy schedule, questioning the need for performing so many different types of physical exercises, protesting that the acrobatic exercises could be dangerous, and so on. Gherman Titov, for example, agreed to participate only in acrobatics, which, by the way, he was quite good at (much better than some of his fellow-trainees). But he had no desire to take part in the strenuous morning exercises and received quite a few reminders from his superiors. Even the other trainees reprimanded him in a wall newspaper which carried cartoons by Aleksei Leonov, who was later to make the first "space walk".

Those trainees who were immediately able to overcome the hardships of that early period set a wonderful example. Soon we had no serious complaints about how the men were exercising. But another problem arose. The invigorating competitive games the men played were beneficial, but they sometimes resulted in injuries. However, the instructors could not now object to the bumps and bruises, and the men who were injured just became more cautious and improved their agility.

Two highly skilled specialists, A. I. Susoyev and E. D. Cherkasov, were responsible for constructing, furnishing and equipping buildings in the Centre. It was no easy task to start with a tract of forest and build from scratch special facilities, provide communal services and communications and equip labora-

tories and classrooms. And though individual organizations did the actual construction work, serving as the contractor in this new field was a difficult job in itself. After all, even the scientists working at the Centre could not always clearly describe their needs. For example, after construction on the first simulators began, several omissions and errors were discovered, and the initial designs had to be quickly redrawn.

Young, inquisitive and bright, the future cosmonauts came in contact with many people whose job it was to help them to train for space flight. The trainees quickly took stock of the situation and discovered which instructors were smart and competent, which were mediocre and indecisive. I did observe this: the cosmonauts were immediately attracted to strong-willed and talented individuals.

I have already mentioned the significant role Chief Designer Academician Korolev played in the character development of each future cosmonaut. Immediately after meeting the first recruitment of cosmonaut trainees, Sergei Pavlovich took an interest in their affairs.

Korolev was a distinguished engineer-designer, brilliant organizer of scientific research and an intelligent, daring experimenter of original technology. He was also a keenly observant psychologist and remarkable influential leader—a leader on whose behalf people would walk willingly into fire.

I met the Chief Designer at a time when he was at the height of his fame, and it is possible that this situation influenced our joint endeavours. Looking through my personal records, I recall my first impressions about Sergei Pavlovich Korolev.

Talented and capable, Korolev was also invariably strict and concentrated on the matter at hand. A complicated and intense man, he kept others in a state of suspense, wondering what he might do next.

This, plus his relentlessly demanding character, was what people remembered most.

In a matter of minutes, if not seconds, Sergei Pavlovich could completely turn around what appeared to be a firm opinion or decision. On the other hand, he could just as easily resurrect a rejected proposal (one that he himself might have rejected) and point out the advantages that had been ignored previously. The man was incredibly capable, analytical and perceptive. His logic was unassailable; his convictions—unshakable. We are not speaking here of a director's capricious nature in everyday affairs. On the contrary, Korolev constantly had the final say in the most complex matters dealing with engineering design, technology and organization.

It is probably apparent now why Sergei Pavlovich's workers were apprehensive whenever they had to enter his office. The Chief Designer was a director who understood the gist of matters. He would take personal offense against anyone who demonstrated a careless attitude to his job. So those who worked under him feared being classified as lazy, negligent or (worst of all) unreliable.

But when the inexperienced young cosmonaut recruits showed up in their air force uniforms, a change came over Korolev. He showed concern for the trainees and even took on the role of their guardian. No one knew what the future held for these first rocket test pilots. And Korolev, overworked as he was, took the time to show patience, uncharacteristic tactfulness, warmth and concern.

At first I couldn't understand why Korolev had such a special relationship with our young pilots. After much thought, I decided that the answer must lie in the past.

Even as a child Sergei Pavlovich grabbed for the sky: the thrill of flying captivated him completely.

He realized early on that aviation had a great future, and he eagerly studied everything connected with flying machines and their testing. Exceptionally determined and industrious, and also remarkably talented and persistent, Korolev managed both to study engineering science and design gliders and airplanes. At the same time he received his diploma from a flight school.

Sergei Pavlovich often spoke of his love of everything to do with aviation, especially piloting. But for various reasons he was forced to discontinue flying and concentrated on developing aviation technology. Frustrated in his hopes to become a test pilot, Korolev was unhappy at not having the opportunity to evaluate in the air what he created on the ground. A man of vision and experience, he deliberately established contact with those pilots fascinated by aviation. It didn't matter if they were young and inexperienced, as long as they were completely dedicated. Korolev realized that he would soon have to trust them to test the new space technology. Though he was by nature reserved and stern, Sergei Pavlovich sought young men who would not be afraid to speak their mind to any figure of authority.

The test pilot in Korolev allowed him to imagine what space flight would be like. And he felt the need to share his fantasies with the cosmonauts, whom he himself had helped select and train. Whenever he had the chance, Sergei Pavlovich would invite the future spacefarers to fantasize along with him.

Korolev showed his concern for other pilots as well. To the surprise of many, he invited the senior cosmonaut-training instructor for spaceship control systems, Mark Lazarevich Gallai, to witness the launch of test rockets prior to the manned flight. Yet it was the Chief Designer's cardinal rule that only those directly involved in the test be allowed to ob-

serve the launch. Nonetheless, Gallai witnessed the *Vostok* lift-off with Gagarin and all the other *Vostok* missions. Mark Lazarevich had earned Korolev's trust and in effect served as his consultant.

Korolev soon acquired a famous test pilot for an assistant—Hero of the Soviet Union Sergei Nikolayevich Anokhin—who was responsible for selecting future cosmonaut-researchers and flight-engineers among the young, healthy and courageous men. Sergei Pavlovich believed that in the near future our space programme would require not just pilots but many different kinds of specialists.

Neither Gallai nor Anokhin had to make an appointment to see Korolev. The Chief Designer received them and listened to their advice any time.

Everyone associated with the *Vostok* space missions remembers who were the real heroes of the Soviet space programme. And Academician Korolev has always been the principal figure among this illustrious group. He had a manly appearance, strong facial features and an intelligent, piercing gaze; he would clearly state his opinions, but he also carefully listened to what others had to say.

As perhaps no one else, Sergei Pavlovich clearly visualized the end results of our work. He urged all of us who were active in the space programme to work together.

Korolev was never too busy to render assistance. I don't remember ever having to wait even for the most important and weighty decision if it was needed before work could proceed. We were amazed by his engineering intuitiveness, his ability to always be informed about numerous different projects, to demonstrate a precise understanding of the work being conducted in each separate division. Sergei Pavlovich quickly and efficiently eliminated the obstacles and difficulties that hampered our work. I don't recall

him ever forgetting to relate an important piece of information or failing to explain a task in detail to an employee at the Centre before checking up on the work's progress. Korolev was a hard-working man who did not spare himself. A dedicated worker himself, he relentlessly demanded the same of his colleagues and associates.

Sergei Pavlovich rarely wrote anything down, but he forgot nothing. He could precisely formulate each routine task of the overall project, visualize the final result of a decision and find and hire competent employees, instilling in each worker confidence in his ability to do the job entrusted to him and in the successful outcome of the whole grand scheme, of which he, the worker, was now a part.

By the 1960s Korolev's prestige was so great that it in itself was enough to guarantee a good deal of success. Naturally, the work collectives directly associated with the new area of space research carried out Sergei Pavlovich's orders. But the Chief Designer's advice and wishes also became law.

Psychological support was given the cosmonauts at meetings of the technology experts (Korolev, himself the project's technical director, invited the cosmonauts to attend) and sessions of the State Commission where reports were heard from the directors of the larger collectives working on the rocket. The ceremonious atmosphere of these meetings and the presence of the documentary film crew reflected the importance of the venture and the enormous responsibility of each participant.

It soon became a tradition for the cosmonauts to meet with the rocket maintenance crew before lift-off. The meetings took place by the rocket, which had been thoroughly tested and was ready for launch. "These meetings," Korolev observed, "allow the cosmodrome specialists and cosmonauts to look

each other in the eye and thus be assured that the work done on earth was carried out conscientiously, and that the work to be done in space will be carried out just as conscientiously.

The evening before lift-off, the spaceship commander and his back-up were moved out of the hotel and into a separate house near the assembly and test facilities and launch position. This gave the Chief Designer, who lived in a small house nearby, the opportunity to look in on the cosmonauts and wish them well.

Sergei Pavlovich insisted that the rocket commander and his back-up be prepared for launch in a ceremonious fashion. Both cosmonauts were formally driven by bus to the launch site, where the commander, in accordance with military decorum, stated his mission to the chairman of the State Commission.

Korolev thought it was psychologically beneficial to have the back-up cosmonaut wait in a bus near the rocket up to the time of the launch. The Chief Designer understood that man is an emotional creature for whom moral education was more important than technical training. Sergei Pavlovich firmly believed this, though he still considered training very important. The cosmonauts used the same credo pilots had held for years: "Hope for the best, but prepare for the worst." In addition to his work in the training programme, each employee at the Centre was concerned with the moral and emotional conditioning of the cosmonaut trainees.

In March 1961 (almost a year after we had moved to Star City), we were visited by a high commission that was to evaluate what the first group of cosmonauts had learned in their training and hold a "space programme audition" for each of the first six. In a manner of speaking, it was both the six cosmonauts who were being tested and our young team of experts

at the Centre. We had to prepare a detailed dossier for each cosmonaut. In addition to concrete facts—data, evaluations, observations down to the milliseconds and milligrams—we listed the findings and conclusions upon which we based our evaluations of each cosmonaut.

Each dossier included a character reference with information about the cosmonaut's professional and Party history and medical (psychiatric and physical) background, and indicated whether he was prepared for space flight.

It had taken enormous effort and carried great responsibility, but all six cosmonauts were recommended for the first space launch...

After thoroughly studying all the material and subjecting our cosmonaut trainees to extensive examinations, the Commission was satisfied with their high level of knowledge and wholeheartedly agreed with the conclusions of the experts and managers of the Cosmonaut Training Centre. This decision was written into a protocol that has now become a part of history.

Now the project's technical experts and the State Commission in charge of the entire training programme requested that the Centre formally recommend the first cosmonaut and his back-up. As a matter of fact, we at the Centre had been preparing such a recommendation since that day in late summer 1960 when we selected our Vanguard Six for preflight training. Thus for over seven months the Centre had been conscientiously and objectively considering the selection of the candidate most suitable for the task, one who would serve as an example for all other cosmonauts (and not only them) and could cope with the fame that would follow the flight.

In comparing the six trainees, we concluded that Yuri Gagarin was the most suitable candidate. The

choice was made honestly and objectively, without reservations. Yuri was a man of character and integrity. He was both kind and charming, not just on happy occasions but under great stress as well. The experts at the Centre recommended Gagarin as the first cosmonaut and Titov as his back-up. Our decision was approved and upheld at all levels until it was finally realized. Gagarin, as we all know, did not let us down. He conducted the entire flight in an exemplary manner.

The selection was based on an understanding of the results of the cosmonauts' training. This was a collective evaluation of the experts at the Centre. Rejecting some and approving others, the experts finally agreed upon the data which in time would allow them to make a well-grounded decision as to who would be the most suitable and reliable candidate.

Not those who merely participated in some section of the general programme, nor those who took our decision on trust and approved it were actually responsible for the final recommendation. The greater share of responsibility was borne by the experts at the Centre whose duty it was to make the timely and competent decision.

Korolev came to love Gagarin as a son. He believed that Yuri personified the eternal youth of our people: "In him are fortunately combined natural courage, an analytical mind and exceptional vigour."

Soon after the world was astonished by the news of the first manned space flight, more of the cosmonaut's talents came to light—talents that we, and in all probability Yuri himself, never suspected. He graciously fulfilled his duties as a distinguished representative of the Soviet Union and supported the cause of peace. And he became the mentor of the other Soviet cosmonauts. Gagarin was also named deputy director of the Cosmonaut Training Centre,

and his appointment was by no means a token one.

Konstantin Petrovich Feoktistov, a cosmonaut-researcher and Hero of the Soviet Union, has warm recollections of Gagarin: "Gagarin never even tried to play the role of a unique individual. He clearly understood that he was an ordinary man in extraordinary circumstances. Few individuals have the gift to be themselves no matter what happens. Gagarin reacted calmly and rationally to his head-spinning fame and gained a reputation for being a modest Russian fellow who was given the opportunity to be the first man in space."

Occasionally a journalist would ask, "Did the training of American astronauts, which had begun a year before the Soviet programme started, influence the training of Soviet cosmonauts?"

It was not a coincidental question. Commentators abroad had begun to try to downplay the significance of the Soviets' venture into space. Here the reader should be given some background information.

The cosmonaut training programme primarily depended on the type of available technology, and provided for the acquisition of the specialized knowledge and skills which would be needed by the cosmonaut in flight. On the other hand, the *Mercury* mission required the American astronauts to play an active role at all stages of flight. For this reason and in order to test the effectiveness of the spacecraft's manual controls, it was necessary to stage preliminary suborbital ballistic flights. Admittedly, the American astronauts and specialists faced a difficult task. Our cosmonauts, however, would be flying the fully automated *Vostok* ship and would not be required to constantly have it under manual control. Therefore, our training programme proceeded more rapidly, for we could dispense with suborbital flight testing.

Another principal difference between the two technological systems aboard the Soviet and American spacecraft existed: the astronauts in the *Mercury* breathed pure oxygen at a significantly lower cabin pressure, while the cosmonauts aboard the *Vostok* breathed a mixture of gases similar to that of the earth's atmosphere at normal cabin pressure. Thus, the demands placed on the American astronauts were greater than those on the Soviet cosmonauts. However, our cosmonauts would be the first in space and therefore were compelled to prepare for the unknown. Even the important information supplied by scientists and the work of competent engineers could not serve as a guarantee against unforeseen circumstances. Our researchers were working with incomplete information, yet they did everything possible to lower the risks of the first space flight and ensure the safety of the cosmonauts.

The fundamental difference between the American and Soviet selection and training programmes was that the Americans were training a pilot who could skillfully control the *Mercury* spacecraft while we wanted a cosmonaut who could evaluate the capabilities of the human organism in space. Additional responsibilities were not considered at the start of the space flight programme. This was something that would require much careful consideration, research and testing. The tasks assigned the first cosmonauts were not difficult. But, again, it must be remembered that Soviet cosmonauts were the first to orbit the earth, to spend one, three, four and five days in space, to include a woman in a three-day flight. How could we have given them more difficult tasks to fulfil when the nature of the initial undertaking was so complicated in itself?

After the successful completion of the *Vostok* missions, Soviet scientists were able to verify and

analyze the information obtained. Moreover, experience revealed that the cosmonaut was able to play an active role in space flight. Initially he maintained only partial control with a parallel automated back-up system and strictly programmed flight control.

When the scientists and specialists working in the space programme became convinced that man was capable of living and working in space, they lowered somewhat their initial stringent health requirements. Journalists would tactfully ask: "Is it possible that a bit too much caution was exercised in selecting and training the cosmonauts?" In some ways, yes. But with good reason. First of all, it should be remembered that we knew nothing how the human organism would react to weightlessness, radiation, acceleration and deceleration, temperature changes and the spacecraft's spinning on three axes. Second, unlike engineers, who can if need be provide a back-up technical system, physicians, unfortunately, have no such reserve system for the human organism. This was why it was so important to choose those individuals strong in body and mind for the first space missions.

I would like to address another issue that was raised abroad. The allegation was made that Gagarin was not the first cosmonaut the Soviets sent into space. It was rumoured that others had died during launches, and that Soviet scientists had managed to conceal this information. Most of the foreign journalists who touched upon this issue seemed themselves embarrassed by the impertinence of the question. But they wanted to know the truth, to look Gagarin in the eye and hear the intonation of his voice. No doubt these gullible people thought least of all about who might want to spread such calumny and why.

Upon hearing these allegations, Korolev remarked

that no scientist or worker of integrity employed in the space programme would have been involved in such a despicable deed. Gagarin, who was standing nearby, immediately added that although he was not personally acquainted with the American astronauts, as a pilot and a cosmonaut he was certain that his colleagues overseas were incapable of such ignoble suspicions. Only those for whom the words "honour" and "conscience" had long ago lost their meaning, those who would denigrate anything if it pertained to the Soviet Union, had the talent to make such allegations. As we see, sending the first man into space also evoked an anti-Soviet reaction.

Fortunately, all over the world (which, as our spacefarers tell us, is really quite small) the numbers of those who are hostile to the Soviet Union are diminishing. There is a saying in the East: "The dogs may bark but the caravan keeps moving." But it is too bad that even today the gullible heed such barking.

In drawing to the end of my recollections about the training of the first cosmonauts, I must stress yet again what an important role was played by the Chief Designer of Rocketry, Sergei Pavlovich Korolev. He was a brilliant scientist, engineer and organizer. And the first Soviet cosmonauts felt the influence of his strong will and logic, and also his paternal concern. All Soviet cosmonauts regard Korolev as their wise mentor.

The names of Korolev and Gagarin have not only come to symbolize the space age, which began with the launching of the first artificial satellites and the first manned space flight, they stand for courage, heroism and loyalty. As time goes on, the historic date of April 12, 1961, will continue to gain in significance, and the achievements of Soviet science and industry will shine even brighter.

Four hours before lift-off on April 12, we were all on the job. As the communications system was being checked, I heard the nervous voices of my friends. Some were just a few metres away, others—thousands of kilometres. As the hours passed, the tension mounted: everyone was concerned and anxious. When the announcement came that it was five-minutes until lift-off, my nerves were as taut as guitar strings, ready to twang if so much as touched.

In just a few minutes the irreversible countdown would begin: the launching mechanism would be switched to automatic control. Who could predict what awaited Yuri in the darkness of space? What would happen on his pioneer voyage into the universe?

I closed my eyes and pictured two powerful projectors—science and technology—crossing their beams, their union forming the cigar-shaped rocket cone. There, sitting in the very tip of the cone, was Yuri. What was he feeling? Did he realize the importance of his mission? Would he be successful?

Of course! Yuri could do it. No one had any doubt about that. And I am certain that at that moment he was calmer than the thousands of us waiting and watching. He, after all, had work ahead of him,

work for which he had carefully trained. The rest of us who had prepared for the first manned space flight, from the Chief Designer to the mechanic who closed the *Vostok* cabin hatch, were now just passive observers. We could only wait. The writer Konstantin Simonov expressed the feeling well: "We do not know the price of waiting, the lot of those left behind on earth."

Lift-off! One hundred and eight minutes around the world. One hundred and eight minutes of anxiety. One hundred and eight minutes of agonizing waiting. One hundred and eight historical minutes!

When we learned that Yuri had landed safe and sound, we threw ourselves into each other's arms. We were deliriously happy. The tension built up over the past few days had to be let out. And it was—in unbridled joy.

To unwind a bit and discover how people were reacting to the news, I got out of the car before I reached my hotel and made my way through the centre of the large Siberian city. I recall my dismay at the indifference with which people seemed to be accepting the staggering news. The city was functioning as usual: trams and buses were running, and people were rushing to get somewhere. Only the bright April day seemed to welcome the event. What was wrong? I wanted to stop each person I met and yell: "Do you realize what has happened? Less than two hours ago man conquered space!"

Later I understood. People had not been indifferent; the majority had just found it difficult to believe. It was too incredible! After all, the mass media had not covered the space programme or the launch. But when the truth was realized, everyone was seized with patriotic fervour. I could see this for myself standing on the platform of the Lenin Mausoleum when Yuri greeted the Muscovites. The thousands of

people standing in Red Square seemed to me to be one human organism, excitedly laughing and crying for joy.

Much has been written and said about the first cosmonaut, so much in fact that it would seem there is nothing more to add. Novelists and journalists, relatives and friends, those who barely knew him—all have written about this wonderful man. If only all these words could bring him back to us!

"My entire life up until now seems but one glorious moment," Gagarin said as he waited to be launched into space. And for us, his friends and co-workers, Yuri's life also seems to have been but a moment. But that moment will live forever in the hearts of those he touched. We cherish the memory of our friend. And no matter where we are—in our own country or far beyond its borders—we speak first of Yuri, the Pioneer of the universe.

I am grateful that fate allowed me to meet Yuri Gagarin. For over twelve years we, and a small group of others like us, travelled the same road, working to accomplish an important task. We were happy and proud to participate in the start of the manned space programme, to train for the first rocket launch and be the first to "look at our world from beyond." We were lucky to have been born just at the right time: five years earlier and we would have been too old; five years later, and the path would have already been blazed. One way or another, others would have accomplished the great feat, not us.

Yuri and I met long before the cosmonaut training programme was started. I had gone to the Far North to continue my military service and was very happy to find that many graduates from the Odessa Flying School were serving there as well.

Misha Andreichenko, who had played first

trumpet in our school band (I was also in the band), lectured me on the topic, "All about the North". And it was Misha I turned to for an explanation when I saw a small group of pilots dressed in air force instead of black naval aviation uniforms.

"Oh those guys. They're just a bunch of footsloggers," Misha remarked. Andreichenko was Navy and felt imminently superior to a member of any other service branch. "They're just as green as you are," he went on, "from the Orenburg Academy." He didn't even notice that he had offended me. And I didn't like the way he dismissed those fellows as "footsloggers" either.

Not that Misha didn't have every right to act superior. He had been in quite a few predicaments while serving in the Arctic and was a great pilot.

Some time later, when the garrison gym was inaugurated, Misha, who was a basketball team captain, advised me before our game:

"All I want you to do is guard that little guy over there," he nodded in the direction of the shortest player on the opposite team.

"He's not very tall, but he's quick. And he has sharp eyes. You'll be plenty busy."

After the game I approached my team opponent. I liked him for not making a fuss about all the times I nearly fouled him. It had been difficult trying to guard him: he was the team's best forward.

"You certainly made me run! Let me introduce myself: Georgi. Just call me Zhora."

"I've heard about you. Gagarin is my name. Yuri Gagarin. Let me tell you something. I didn't play my best today. Next time, you better watch out, *footslogger!*" *He said this with a grin.*

I was surprised that Yuri so casually accepted this epithet. Later, among the other cosmonauts, we grew used to hearing him call the men "footsloggers".

And we were even able to tell how he felt about someone depending on his intonation.

I remember once how Fyodor Demchuk, who was teaching Yuri how to drive at the Cosmonaut Training Centre, became irritated and shouted:

"I am not a footslogger. I've been behind a wheel my entire military career."

"Fine with me ... motor-footslogger!" Yuri answered. From that day on Fyodor Demchuk was known as "motor-footslogger".

Gagarin and I didn't see too much of each other at first. We would meet occasionally at the airfield, the Officers' Club, the gym or out skiing: "How are you?" "Hello!" "How are things going?" "Alright." "So long!" "So long!" And we would continue our separate ways.

The situation changed completely that memorable autumn day when Yuri and I discovered we were among the six selected to be examined by a medical commission in Moscow. We were uninformed about the nature of the work, and that made it all the more mysterious. Yuri and I became close friends as we waited to be sent to our new assignment. We were advised not to speak of it even to our friends, so we relied on each other.

In Moscow, Gagarin immediately made friends with all the recruited men. I marveled at how easy and natural it was for him, since I myself find it hard to get to know people right away. Yuri was at home with the bachelors as well as the married men. And when a small group of men was selected to begin immediate training for the first space flight, no one was surprised that Gagarin was at the head.

Yuri passed all the tests and training procedures with ease. Even when sitting in the plane a few minutes before parachuting, he was able to joke with his suddenly silent comrades or would urge Pavel

Popovich to sing a song.

"Come on Valery, sing along," he would tease the morose-looking Bykovsky sitting opposite him. Bykovsky never sang along even when he was in the best of moods. And, in fact, no one felt like singing then. We had only just begun to parachute and had not yet come to love this daring sport.

When I compared my inner nervousness to Yuri's outer high spirits, I began to doubt myself and turned to our dauntless trainer for advice:

"Nikolai Konstantinovich! I understand why you aren't afraid to jump. You've parachuted three thousand times already, and have had some really close calls. It scares me even to listen to you talk about them! But I can't understand Yuri. He's just like the rest of us; he hasn't even made ten jumps yet."

"You simpleton! Yuri's joking and singing is a defense mechanism. That's how he maintains control, and helps the rest of you remain calm at the same time. And who ever told you that I don't get nervous before a jump! You think I'm made of steel? No one is totally fearless except a fanatic or maniac, in other words, someone with an abnormal personality. Bravery means being able to control your natural instincts. You've heard of the self-preservation instinct? Without it the human race would have disappeared at its first stage of development. The reason we are spending so much time training you men to parachute is to help you learn how to control that instinct. Understand?" He gave me a piercing look and then added emphatically: "I'll make men of you!" To conclude our conversation, he jabbed me in the shoulder with his iron fist.

"And another thing," Nikolai Konstantinovich wasn't finished: "When you meet someone walking down the street, make sure he's the one who moves out of the way to let you by."

After that conversation, I began to take a different view of Yuri's antics. I knew they weren't a sign of a reckless nature but a calculated form of behaviour. And this was demonstrated by his highly successful completion of the testing and training exercises. It was clear that Gagarin realized his potential and had such confidence in his capabilities that he would undertake a totally new activity with total aplomb.

"I do it as they taught me," Yuri smiled, letting us in on the secret of his success. There was nothing egotistical or vain about him.

Generally, before one of us would go for a training exercise, he would seek the advice of the others who had already been tested. So, when it was my turn to stay in the altitude chamber for a prolonged period, I turned to Yuri. I had heard that both the physiologists and psychologists had praised him for his composure and self-control, his strength of mind and steady nerves.

"There's nothing to it. Just do what they taught you," Yuri told me. Then, seeing that I really needed some advice, he put his arm around my shoulder and quickly added: "Come on. Let's sit under that birch tree and talk."

We sat down on the pale grass under the yellowing birch. Star City had many birches, and, like all Russians, we were sentimental about them. For a long time Yuri looked silently up at the clear but dim autumn sky. Then he suddenly asked:

"Do you have a favourite state of mind you can remain in for a long period?"

His question, which appeared to have nothing to do with our conversation, surprised me and at the same time made me think.

"Yes, of course, I can look at the sky for hours on end or sit quietly on the shore listening to the

waves breaking. And I like to watch a fire."

"And do you talk or listen to your neighbours or to music at the time?"

"No, I do not. I retire into myself. Everything around me disappears. And it seems to me that I alone face the sky, water or fire."

"And did you never think that each time you were experiencing the same sensation—silence? You were listening to silence!"

I thought Yuri's observation a bit strange, but I didn't contradict him. He went on:

"At times I have given myself over completely to silence. You can't even imagine it. I have always loved the quiet. The quiet of contemplation, of work... It's a pity that in our fast-moving twentieth century we have less and less time for silence." Yuri sighed and added in a different tone of voice altogether:

"You have the fantastic opportunity to spend fifteen days thinking and working in absolute silence, to listen to its enchantment. So make the most of it. Do you understand now what I'm talking about?"

Yes, I thought I did. I had just discovered another side of Yuri's character. Now I understood why, regardless if we were in class, riding a bus, walking in a forest or even exercising, this fellow who was always bursting with energy would suddenly grow silent and for a few minutes tune out everything going on around him.

Gagarin was enthusiastic about the training programme. At that time we hadn't yet acquired the equipment that could really simulate the conditions of space. For this reason, the efficacy of training depended to a great extent on the imagination of the trainee, on how well he could visualize the procedures and conditions that could not be simulated. In this as well, Yuri excelled.

He shared his space flight training experience with us:

"Of course our simulators can train us to react automatically to any situation. But we aren't machines; we have minds. We must use them to conceptualize what the simulator is incapable of. Ever since I was a kid I've had a vivid imagination. When I'm sitting in a test chamber or behind a simulator, I pretend that I'm in a spaceship. I close my eyes and see the continents and oceans passing under me, I watch day turn into night, and somewhere far below I see the golden patches of city lights shining in the darkness."'

Gagarin always saw his goal and strove purposely to attain it. When, on December 1, 1960, one of the unmanned *Vostok* test rockets crashed, killing the two dogs on board, and causing much worry among the space programme workers, Yuri merely commented:

"It's a pity that such an expensive rocket crashed. But it's inevitable that such an ambitious undertaking as this should incur loss."

We cosmonauts carefully followed the training of the American astronauts. We knew all about each of the seven brave men selected for the *Mercury* missions.

Yuri expressed our common wish when he said: "Sooner or later one of us will meet one of them and discuss our observations and experiences. I'm sure of this. Space flight will bring our two countries closer together."

The joint space venture Gagarin had dreamed about was made, but he didn't live to see it. Preparations for the mission and the flight itself greatly helped to further detente: it showed that together our two great countries could explore space more effectively and set an example for the rest of the

world to follow, not only in the sphere of space research but in all spheres of human activity.

The Cosmonaut Training Programme continued as usual. The final *Vostok* test launch with the mongrel dog "Starlet" (Yuri had suggested the name) and "Uncle Vanya", a mannequin comfortably seated in the pilot's seat, was completed successfully. Yuri and the five other cosmonauts trained for the first flight made a trip, now a tradition, to Red Square before leaving for the cosmodrome. They wandered around the square, mingling with the Muscovites. No one had any idea that in a few days time an event would take place that would shake the world, and that the principal role in it would be played by one of these senior lieutenants dressed in aviation uniform nonchalantly strolling around Moscow that spring day.

When later asked what prompted him to go to Red Square before flying to the cosmodrome, Yuri answered:

"Before embarking upon an important path in life, the Soviet people have come to feel an inner need to visit Red Square, the Kremlin, Lenin's Tomb. Twenty years ago, the Home Guard marched in a parade in Red Square and went straight to the front-line to defend the capital. Young people come to Red Square after they graduate from school. All Soviet people and our country's foreign visitors come to Red Square. Moscow is the heart of our Motherland, and Red Square is the heart of Moscow."

Before leaving for the cosmodrome, all cosmonauts now follow the path Yuri travelled on earth as well.

When the first group of cosmonauts was ready to leave, the entire detachment gathered to wish them farewell. I spoke up as well:

"We envy you, but in a healthy, friendly way.

Though we will remain here on the ground, our hearts will be with the man selected to make the first manned space flight in history."

I addressed my remarks to all the men, but we assumed that Yuri would be the one to go.

Gagarin spoke too:

"I am happy and proud to be one of the first cosmonauts. And if I am trusted with making this first flight, I will accept the responsibility worthily and with great gratitude, and I will fulfil my task as befits a communist."

We all would have liked to have taken Yuri's place. But those who had trained for this first flight along with him felt the desire even more keenly. Yet all the men were on good, friendly terms, there was no hint of rivalry or competition. All of us were involved in a common and very important mission, and we all subordinated our own thoughts and actions to the successful completion of that mission.

Gagarin's relationship with his back-up, Gherman Titov, is illustrative. Yuri recalls their trip to the cosmodrome in his book: "Gherman Titov was sitting beside me, and I found myself studying the regular features of his handsome, thoughtful face... He was as well-trained as I was and, in all probability, more capable. Maybe they were keeping him for the second, more complicated flight."

When Titov went up in space, Gagarin was far from the cosmodrome, in the western hemisphere. But in his heart and mind, he was at Baikonur. Upon hearing of the successful launch of *Vostok-2*, Yuri, who was in Canada at the time, asked his host, Cyrus Eaton, to arrange for his trip back to the Soviet Union. And despite the unfavourable flying conditions, Gagarin returned.

Not taking the time to rest after the exhausting flight across the Atlantic Ocean and Europe, he

hurried on to the Volga, to the area where Titov had landed.

Yuri later described their meeting:

"I found Gherman in the familiar two-storey house where I had rested after my flight in space. Lean and lithe, strong and incredibly agile, even after spending an entire day in orbit he exuded health. Only his wonderful, expressive eyes revealed his fatigue, which even his smile could not hide. I was overjoyed to see him. We embraced and kissed like brothers, united by our experience in space."

Yuri showed much concern for all the cosmonauts. We knew our friend and commander (after his flight Gagarin was named commander of the cosmonaut detachment) was interested in our work. I recall how one day he asked me to stop by and reminisce about the North. About nine o'clock that evening, I met him at his home.

"Make yourself at home while I put these two magpies to bed," he said as he picked up his two daughters. The girls kissed him loudly on both cheeks and then went to bed.

"I asked you here on a serious matter," Gagarin said. "A difficult flight is being planned. We have a commander, and I'd like to suggest you as his partner. I know both of you are strong-headed, and you might have difficulty getting along. But I also know your self-control and I think you could make a good crew. Think about it a few days and then we'll talk again." To signal the end of that discussion, he changed the subject: "How's Andryusha getting on? And how's Sofia Vladimirovna?"

When he heard that my mother was not feeling well, he offered some advice and then suddenly asked:

"What's your favourite childhood memory?"

"I used to love to lay my head on my mother's lap and listen to her sing while she stroked my hair,"

I admitted in some embarrassment.

"I used to love it when my mother kissed me between the shoulder blades as she put me to bed," Gagarin said. "When she did that it seemed to me that I was the happiest little boy in the world."

We were all amazed by Yuri's wide range of interests and deep emotions, and also by how he expressed them. Standing at the base of the rocket minutes before lift-off, aware of the significance of the momentous occasion, he spoke as only a true patriot can speak. Using words he later acknowledged he had never before spoken in everyday speech, he touched the hearts of his friends and comrades, the hearts of all his countrymen and people throughout the world.

...Gagarin had his own special understanding of beauty in nature and man. He saw it everywhere, no matter how deeply hidden it was. He thought of the unseen and unknown world he was to explore as beautiful. Stepping from the bus which had brought the cosmonauts to the launch site, Yuri looked across the desert steppe bathed in the morning sunlight and exclaimed: "Look at the beautiful sun!"

One of the other cosmonauts later wrote: "The words were as unexpected as hearing a gun shot in the quiet of morning. We all turned to the east. The sunrise was indeed magnificent."

Gagarin informed the Chairman of the State Commission that he was ready for his mission and received the farewell wishes of friends, scientists and engineers. He gazed for a moment at the rocket, which, in the rays of the rising sun, reminded him of a lighthouse. Again he was moved by the beauty of it all. He later described his feelings: "I looked at the rocket which would take me on an amazing voyage. It was beautiful. More beautiful than all the trains, boats, planes, palaces and bridges put together.

I thought this beauty was eternal and would remain for the people of all countries for all future times. I was not just standing in front of a magnificent piece of technology, but an impressive work of art."

In his first report after he had entered orbit, Yuri admired our world:

"I see small clouds over the earth and their shadows. It's beautiful!"

When we spoke with him after his flight, we eagerly questioned him: "Yuri, what does the world look like from outer space?" Gagarin thought for a long while, smiling distractedly. He was obviously thinking back to what he had seen from the window of the *Vostok*. Finally he answered:

"It is magnificent! There are no words to describe how beautiful it is, you must see it for yourself. It's blue!"

We weren't quite satisfied with that answer, but after our own trips into space, we realized that Yuri was right. It is impossible to reflect true beauty through words or even the most expressive paintings. It must be seen and felt by the individual. So it is not surprising that space impressed each of us differently. The paintings of outer space by Aleksei Leonov do not much resemble my view of it, or that of Nikolayev, Gorbatko, Sevastyanov, Khrunov or Popovich.

Yuri was in truth a wonderful person, and he was surrounded by people just as remarkable and interesting. His friends included the composer Alexandra Pakhmutova, test pilot Georgi Mosolov, the distinguished surgeon Alexander Vishnevsky and many other exceptional Soviet people. In any gathering, he was a sought-after and interesting conversationalist. People were attracted to him, and he met them with an open heart.

The day after he went up in space, Yuri gave a thorough account of the spacecraft's operation systems and described in detail what he had seen and experienced. He spoke at length, for his impressions were many, and he wanted to describe his unusual experiences while they were still fresh in his memory. We listened to him without interrupting, and when he had finished, pelted him with questions. Yuri took his time in answering each of us, aware that we did not ask out of idle curiosity. Each question was important for future work in developing new spacecraft and preparing for the next flights.

Yuri thought that once he returned to Star City he would carefully contemplate his experience, make certain recommendations and then take direct part in preparing for the second launch. He knew that his experience and the observations he had made during his single orbit would be useful. But Gagarin's plans were not to be fulfilled. His flight had astounded the world, and people all around the globe wanted to see the first Earthman who had travelled into the mysterious universe. Yuri received dozens of invitations from different governments and social organizations inviting him to come for a visit. He was written about in newspapers and magazines: he had become the most famous man in the world.

Three and a half months after his flight, Yuri was making his second trip around the world—this time travelling by planes and trains. Czechoslovakia, Bulgaria, Finland, Great Britain, Poland, Cuba, Brazil and Canada gave a rousing welcome to the world's first cosmonaut. It was during this time that preparations were under way for launching *Vostok-2*. Yuri was very disappointed that he was unable to participate in the work and felt as if he had let Gherman down. This was the only space launch Gagarin missed. For all the subsequent missions he

was able to postpone his travelling and participated directly in the launch preparations.

Yuri's experience, energy, confidence and friendly concern inspired and helped the rest of us. He couldn't sleep the night before Andrian Nikolayev's launch, and spent the early morning hours of August 11 on a bench in front of the house where Andrian himself and his back-up, Bykovsky, were sound asleep. The next day, when someone jokingly asked what thoughts the moonlit night had provoked in him, he answered in all seriousness:

"It was the moon I was thinking about. About the time when man will travel there. And it's not so far in the future. At any rate, it will be sooner than when trade unions start to hand out vouchers for rocket trips into space. And Korolev says that he is sure he will travel on such a voucher himself."

Yuri was also present at the control centre when Valery Bykovsky and Valentina Tereshkova flew into space, and he helped train and launch the first three-man space crew for the *Voskhod-1* commanded by Komarov. Relying on his experience and technological knowledge, he correctly evaluated the situation when the *Voskhod-2* spacecraft with Belyaev and Leonov aboard, failed to begin its descent and continued along its orbital path:

"On the eighteenth orbit you have permission to use manual controls for descent," he informed the cosmonauts without betraying the slightest emotion.

When Vladimir Komarov was launched into space a second time, Gagarin was there—this time as his back-up. To our great grief, this launch ended in tragedy: Vladimir Komarov, a fine man and experienced cosmonaut, was killed. This was the last launch Yuri worked on and attended...

At home I have a picture of Yuri hanging in my

study. Wearing a space helmet, his eyes are bright and expressive, his mouth poised to break into that familiar smile. If I close my eyes, I can picture Yuri in different times and situations, like stills in a documentary film.

...A small group of senior lieutenants headed by instructor Yevstafi Tselikin crowds around the first spacecraft control simulator. For several hours now all our attention has been focused on the simulator. Yuri is inside. He speaks calmly and unhurriedly, giving precise commands and carefully controlling the motions of his hands. Tselikin, who has never been one to flatter anybody, is very pleased: "Not bad," he observes. We all feel very happy for Yuri...

...Smiling a bit self-consciously, Yuri describes his flight at the Training Centre. He looks a little uncomfortable, probably because he didn't expect such sudden fame and glory. We are also ill at ease, and can only stare at this young major with a new Gold Star and Order of Lenin pinned to his chest. It doesn't seem possible that he is our same friend, the guy someone tripped in a recent game of soccer. It's as if a wide gulf suddenly appeared and we don't dare or know how to cross it. Yuri is the one to bridge the gulf and put everything right. He would always be a figure of authority for us, but what we remember about this meeting is his quiet joy, self-conscious smile and inexplicable bashfulness...

...At the aerodynamic laboratory of the Zhukovsky Air Force Engineering Academy, a supersonic test is under way. Yuri and I have pressed our faces against the small window of the aerodynamic tube and watch the model spacecraft. We are oblivious to everything else. From time to time Yuri jots down a few notes. His attention is completely focused on the experiment. When a laboratory assistant asks him for his autograph, his voice is un-

characteristically harsh: "Wait!"...

...It's a hot Sunday in June. For the umpteenth time I am reading over my notes on thermodynamics to prepare for an exam at the Academy. Yuri telephones and asks:

"Zhora, have you finished studying? I have a couple of questions. Can you help me?"

"I'll try."

"Then get your books and let's go to Khimki! We'll swim and relax and then try to figure out this enthalpy and entropy. Alright?"

An hour later Yuri is wearing swimtrunks and standing behind the wheel of a boat. He has a rather fancy hat on his head that looks African or South American in origin. Around his neck is tied a brightly coloured docker's scarf. Squinting at the glaring sun, Valery Bykovsky and I begin to tease Gagarin:

"Hey, Captain! Are you sure this bucket won't sink?"

"Need any deckhands? Captain? Too bad. We would have signed on to work for you."

"Captain! Where's your Jolly Roger?"

Yuri likes the joking.

"What is this? A mutiny? I won't stand for it. As soon as I find a desert island in this ocean I'm going to leave you stranded. You'll be Robinson Crusoe, Zhora, and with your dark complexion, you, Valery, will be Friday." Yuri smiles and at the same time carefully watches the fairway, signalling left and right with waves of a flag...

...Fullscale preparations are under way at the Centre for the first manned *Soyuz* mission. Gagarin has done it—he is among the cosmonauts being trained. For now, Komarov's back-up, he is nonetheless doing what he likes best. And he immerses himself in classes, training, experiments, flights...

...One bright sunny day in spring we all go hunt-

ing for grouse. Snow still covers the ground, but spring is definitely in the air. We awoke early and have been roaming the woods and fields, feeling intoxicated with the smell of spring and sound of the birds. And we aren't at all upset that we have had no opportunity to use our rifles or game-bags. Yuri is the only one to return with a catch. He and Aleksei Leonov watched the grouse for a long time, sneaking up on it while it sang and freezing in uncomfortable positions as soon as it stopped...

After the bus brings us home, Yuri, feeling uncomfortable at being the only one with a catch, protests our departure:

"I won't hear of it. I want you and your wives to come over to my place in an hour and a half. By that time Valya will have cooked this beauty. I think there's enough for everyone to have a taste."

It's a wonderful evening and all the guests (there are twenty of us) enjoy the grouse. Once again we listen first to Yuri and then Aleksei describe how they managed to bag that incredibly clever bird. And then we sing, even Bykovsky. We used to love to sing folk songs whenever we got together...

...One gloomy, grey day in March 1968, I was sitting in the cafeteria. For some reason I din't feel like eating. I kept looking out of the window at the heavy clouds covering the sky. I felt as despondent as the weather. Pavel Belyaev walked into the room with a stony expression on his face. Coming up to my table, he said softly:

"Zhora, Yuri hasn't come back from his flight. He should have been back an hour ago."

"What do you mean he hasn't come back?" I asked Belyaev and immediately got to my feet. I couldn't comprehend the terrible meaning of Belyaev's words. "He probably landed at another airport. What did he say over the radio?"

"We haven't received any communication," Pavel answered. "What if...?" He couldn't finish his phrase.

In a thick forest near Vladimir, Yuri's plane exploded, leaving on the ground a crevice surrounded by scorched birch trees—mute witnesses to the tragedy that took place on 27 March 1968.

The human memory is remarkable; both kind and cruel. It carefully guards all experiences, and in a matter of minutes one can look back on a dozen years. But one also remembers the wonderful times that then were taken for granted, the lost opportunities to express to those who really deserved them the words of love and friendship that now tear at the heart.

Autumn that year was unusually sunny and warm. Sometimes it would rain a short while at night, cleansing and refreshing the air. The next morning I would awake feeling vigorous and strong. After breakfast the entire family headed for a day at the Black Sea. It was pleasant to be vacationing in the Caucasus, away from the stress of work. And I still had more than two weeks of vacation to enjoy.

Unexpectedly, I received a summons from Moscow. During a meeting at the CPSU Central Committee, an official spoke with me.

"Your military comrades have nominated you for the position of head of the Cosmonaut Training Centre."

Noting my surprised expression, he calmly assured me:

"Yes, you are being asked to be the director of our cosmonauts. There is no other organization like it in the country, so you will always be out in the forefront—a difficult position."

In mid-October that same year, 1963, after putting my affairs in order at my previous service post, I took on my new responsibilities.

A few days later Yuri Gagarin came to see me at the Centre.

"May we have your permission to go see S.P. tomorrow morning?"

"To see whom?!"

"The Chief Designer, Sergei Pavlovich Korolev. Everyone calls him S.P."

It was the first time I had heard the Chief Designer of Rocketry referred to in such a desultory fashion, and I was visibly disturbed. My heart even began to race.

Gagarin noticed my reaction and smiled:

"You should also make his acquaintance."

"Yes, but how?"

"Well, if you like, why not come with us tomorrow?"

I was happy to find out from Gagarin that Korolev was a former pilot: a common profession always made conversation easier and helped bring people together.

At the appointed hour our car passed through the first electronic gate and then the second. A young girl in a guard uniform greeted Gagarin with a smile. We went up to the second floor and walked into a bright and spacious reception area. The young, attractive secretary rose to meet us:

"Go right in. Sergei Pavlovich is expecting you."

The large office, with a long table in the centre, resembled a conference hall. Gagarin softly nudged my elbow: a heavy-set man with narrowed eyes walked in from a side door. I stared: one day this man, Sergei Pavlovich Korolev, would be known throughout the world.

Sergei Pavlovich shook our hands and asked us to sit down. I was surprised by the quietness of his voice. After giving us a few minutes to organize our thoughts, Sergei Pavlovich turned to me and asked:

"You have been appointed head of the Cosmonaut

Training Centre?"

"Yes," I answered, and rose from my chair by force of habit.

"Don't stand," he said, never taking his studious gaze from my face, "we'll talk while sitting. You were once a fighter pilot? On what fronts did you fight and what planes did you fly?"

Before I could answer, a telephone rang.

Sergei Pavlovich excused himself and went to a small table by the window. Apparently the conversation was not pleasant: Korolev was frowning. Something had clearly upset him, and he suddenly curtly remarked:

"Alright. I'm on my way," and hung up.

Shaking his head as he returned to us, Sergei Pavlovich said regretfully:

"We'll have to finish our conversation another time. Congratulations on your appointment. We'll be working together. It's a difficult but interesting project, and we'll meet and talk often. Goodbye for now."

I thought about Korolev on the way home. "He seems like an ordinary guy," I thought to myself, "but incredibly strong-willed and even, at first glance, tough. His eyes could pierce right through you. I wonder what role he plays in selecting the cosmonauts, picking the space crews and organizing their training?"

I later learned from the cosmonauts that Sergei Pavlovich Korolev made every single decision himself. He would, I was told, ask the advice of others, but he himself reached the final decision and saw to it that it was carried out. And his word was law for each of the organizations working with the design bureau on this programme.

I remember an interesting occurrence. One day Korolev summoned a young engineer to his office.

"Valery Pavlovich, could you write a monograph about the booster stage you're working on? Specifically, I'd like you to determine the possibility for increasing the payload. I'm sure you understand the importance of such research."

The engineer thought a moment: Korolev was asking him to make a serious commitment. Nonetheless, he quickly agreed:

"I can do it."

"Fine!" Korolev beamed his approval. "Good luck!"

The next day Valery's name with the title of his monograph and date for its completion was listed along with the names of the more experienced scientists and their design bureau projects.

Busy as he was with his own work, Valery didn't think much about the monograph at first. And anyway, he was sure he had plenty enough time to finish it before the deadline. Unfortunately, the time passed all too quickly. And when Valery finally sat down to write the monograph he suddenly realized that it wasn't going to be as easy as he had first thought. He worked late into the night and on the weekends, but he still couldn't finish. He asked to take his vacation and spent the entire thirty days and nights working on the monograph. He made considerable progress, but was nowhere near completion.

Korolev called Valery into his office on the deadline set for the monograph.

"How's the work going, Valery Pavlovich?"

Blushing with shame, the young man explained the situation.

"So you haven't fulfilled your obligation," Korolev said with a touch of sarcasm. "It's the first time, so you'll just receive a reprimand." He paused a moment and then added: "Before making a decision you must carefully consider your capabilities and poten-

tial, determine how much time you'll need and by all means allow yourself a few extra days. Only then should you agree to something and give your word. You yourself proposed the deadline without carefully considering the difficulties of the task. I got the impression that you were trying to be accommodating. But that's not the role of a scientist."

The next morning the disciplinary measures taken against Valery were listed on the bulletin board. Valery was not so much upset by the reprimand as the terse wording of the announcement: "For failure to complete work on schedule..." Another rather short deadline was set for the completion of the monograph.

Valery Pavlovich pushed everything else aside, worked every weekend and holiday, and this time handed the folder to Korolev the evening of the deadline. The following day the Chief Designer called the young man into his office. Korolev was sitting behind his desk as usual, looking as if he hadn't moved since the evening before.

"Sit down," he told Valery when the young man timidly appeared. The engineer later recalled being so nervous that some of his hair turned grey.

As Korolev leafed through the monograph his face showed his satisfaction. Finally he put the folder aside and said:

"This is material for your doctor's degree."

"My doctorate?" Valery stood in surprise. "I don't even have my candidate's yet."

"I can see by the way you've tackled this project and succinctly and clearly set forth your ideas that you are capable of earning your doctorate."

A few days later Korolev appointed Valery Pavlovich a group director and rescinded the disciplinary measures: they had already served their purpose.

Korolev was extremely busy with his work as an

engineer-designer, organizer and administrator, but he also found the time to check on the progress of the experimental production section. He often visited the shops and spoke with the workers, taking an interest in their lives at home and everyday needs. Many of the employees he knew personally by name and patronymic. And they were proud to be working under Korolev.

Once when he was visiting the production section, Korolev stopped to study the board of honour and noticed the photograph of a middle-aged woman among all the men. The woman—a machine operator—consistently over-fulfilled her production quota. Trying not to call attention to himself or distract the workers, Sergei Pavlovich found the woman bent over a machine.

"Good day, Marina Borisovna."

Lifting her head in surprise, the woman smiled:

"Good day, Sergei Pavlovich."

Picking up a machine part, the Chief Designer turned it over in his hand, studying it carefully. He laid the part down and asked:

"How do you manage to exceed your quota each day and still achieve such excellent quality?"

"I love my work," Marina Borisovna answered simply. "I've been with the factory a number of years, and I try not to waste a single minute. We have a good, friendly collective here. Everyone helps out whenever necessary."

"And how are things at home, Marina Borisovna?" Korolev asked. "How's your family? And you must have children?"

The woman's face fell. She turned away and wiped a tear with the edge of her headscarf.

"Have I said something to upset you?" Korolev hastened to ask.

"Oh no!" Marina Borisovna tried to smile. "It's

just that no one ever asked me before. The truth is I wouldn't wish my life on my worst enemy."

The conversation was taking up quite a bit of time, but Korolev didn't seem to notice. He walked around the machine and asked the woman to sit down.

"I'm trying to raise two sons," Marina Borisovna continued. "My husband was severely wounded in the war and died soon after he returned home. I was already over thirty when I came to work at the factory. While the children were young, I managed. But now they are growing up and things are harder. They do well enough in school, but there is no place for them to study. We have a nine-metre room in a barracks. The water freezes in the winter. Once I came home from work and found the boys almost dead from inhaling carbon monoxide fumes from the wood-burning stove. Fortunately, the doctors were able to pull them through. I'm afraid they will fall in with the wrong crowd. But their teachers say they have ability."

"Where are they now while you're at work?"

"Out in the streets. It's not bad when I work the morning shift. But I'm worried sick whenever I have to work in the evening."

Sergei Pavlovich thought a moment and then asked:

"Do you earn enough money?"

"Yes, money is no problem. And we receive regular bonuses so there's nothing to complain about."

At that moment the production section director and foreman walked up.

"We're discussing why things are so bad here and what we can do to improve them," Korolev said in a purposely harsh tone.

"Marina Borisovna is one of our best workers!" the foreman exclaimed. "Even the men here can't keep up with her, and she sets an example for the young workers. A great example! Why, she manages

to find time to do everything."

"Marina Borisovna and the rest of the workers are fulfilling the production target without trouble," the section director added.

"That may be," said Korolev as he rose from his chair, "but Marina Borisovna believes that the work could be better. Yes, better! If only more concern would be shown for the workers. Have you ever been to her home? Do you know in what conditions her family, the family of a war veteran, is living? How her children are being educated without a father?"

"The barracks where Marina Borisovna is living is supposed to be torn down," the section director quickly noted. "We have been promised..."

Korolev stared at the man:

"Today is Tuesday. Are you aware that on Friday people will begin moving into a new apartment building in the city centre?"

"Yes, I know. But we weren't alloted any apartments."

"Listen to me carefully," Korolev's voice had grown harsh. "I want a two-room apartment on the third floor of that building to be transferred from the reserve fund to Marina Borisovna and her children."

The machine operator gazed up at Korolev, unable to believe her ears.

"Marina Borisovna, thank you for your good work. I wish you every happiness." Korolev shook the woman's hand and left the room.

Marina Borisovna remained sitting for a long time. An older worker came up and said:

"Congratulations! You deserve this, Marina. And you can believe the Chief, he's a man of his word."

All the workers were happy for this kind woman who had experienced such suffering. The section director alone refrained from offering his congratulations.

A month or so later, Sergei Pavlovich again visited the production section to check on the work.

Marina Borisovna looked at him reproachfully and then dropped her eyes.

"What's wrong?" Sergei Pavlovich asked with concern. "Is the work going badly or has someone offended you? Have you moved into your new apartment?"

Marina Borisovna sighed deeply and then softly said:

"We've moved to another apartment, but not that one."

"What do you mean?" Korolev was clearly surprised.

"They gave that one to someone else, someone closer to the director. And I moved into his old apartment. It's a little better than the barracks. At least the dogs can't peer in the windows."

Korolev's eyes flashed and he clenched his jaw. He turned sharply to the section director who had just walked up.

"I'm very sorry, Sergei Pavlovich. There seems to have been some misunderstanding," the director hastily sought to extricate himself from the situation.

"Tomorrow morning report to me that my order has been carried out," Korolev commanded and turned and left the building.

The next day Sergei Pavlovich arrived on the job early, as usual, long before the start of the work day. But the section director was already waiting in his reception room. Korolev greeted the watchman and proceeded to his office without so much as a glance at his visitor. Not until an hour and a half later did he ask his secretary to show the director in.

"Your order has been carried out," the man quickly informed Sergei Pavlovich. "They moved in yesterday."

Korolev said nothing. He stared at the short, swarthy fellow, who seemed to diminish in stature under his gaze.

"We are at the beginning of a new age in science," Sergei Pavlovich said in a tired voice. "Our large group of workers is united by a single goal, a common task and mutual trust. The lives of many people as well as the prosperity of our country depend on the work of each of us. You are surely aware that space flight is the goal of our work. Doctors sometimes use the word "psychological compatibility", which means, among other things, mutual understanding regardless of circumstances. Those who are creating the technology, preparing for and controlling these flights possess everything needed for compatibility. But you and I do not."

...Sergei Pavlovich was well aware of the importance of the space programme and considered safety a priority. Speaking at a meeting of directors of the design bureau and production division, the Chief Designer stated:

"We are crossing unexplored territory, and danger lurks at each step. We must discover the danger and avoid it in good time; this will require much effort and knowledge. Many roads lead to error, but only one to the truth. And this is the road we must find. Because flight safety is our major priority, we utilize reserve, back-up and double-back-up systems. Yet despite this, space flight remains problematic and considerably more complicated than modern aviation. Pilots have an appropriate saying: 'There is nothing trivial about aviation; everything is important.' We should take this as our motto."

Following this meeting a number of safety measures were introduced that improved working conditions. But not all the workers greeted the ban on

smoking with enthusiasm, and some even tried to ignore it.

One day Korolev noticed a worker from the technical control section smoking.

"Are you aware of the ban on smoking?" he asked.

"Yes, but it's my lunch break and I..."

"Inform your director that as of tomorrow you are no longer employed here," Sergei Pavlovich calmly interrupted the man and left the factory area.

After the Chief had returned to his office, the director of the technical control section, a veteran worker at the enterprise, came to see him.

"Sergei Pavlovich," he began, "please don't fire this man. It will never happen again, I can vouch for him. He's a good worker ... and, you see, he has seven children..."

Korolev smiled and shook his head:

"Seven did you say? That's great! Tell him to come to my office."

"He's here now!" the director quickly spoke up. "Shall I call him in?" he asked before hurrying to the reception room and returning a few moments later with the culprit.

"Sergei Pavlovich! I'm sorry! I'll never smoke again," the man declared fervently and held up a crumbled cigarette pack in his hand.

"Are the seven children all yours?" Korolev asked with a smile.

"No, three are my brother's. He was killed in the war."

"I see. Well, go on. Back to work."

It didn't take me long to discover that Sergei Pavlovich wanted to be a part of everything that had to do with space flight and rocket technology. The conferences and meetings he held with the chief designers and engineers were remarkably well-organ-

ized. Korolev listened attentively to the opinions of the engineers, scientists and various experts, asking about the minutest details and then making an overall evaluation of the situation and the possible changes that could affect it. Whatever decision he finally reached was compulsory for everyone.

Due to the importance and urgency of the space programme, Mstislav Vsevolodovich Keldysh, President of the USSR Academy of Sciences, as well as many other leading scientists took part in the work of Korolev's Council of Chief Designers. Sergei Pavlovich usually invited to such meetings those directors from the Cosmonaut Training Centre and cosmonauts who were working on the flight programme to be discussed.

Korolev spoke in a quiet, assured voice and invariably used facts and test results to back up his statements. Once in the course of a discussion the question arose as to what type of surface a particular lunar apparatus should be adapted for. Sergei Pavlovich announced unequivocally: "A hard pumice-like surface." Yet this was at a time when many scientists in the world believed that the moon was covered with a layer of dust several metres thick.

I realized right from the start that Korolev liked most to be surrounded by people like him—those who devoted themselves entirely to their work. He had no patience whatsoever with slackers. He was a man of charisma and talented young people believed in him and his vision. Somewhat later I understood that it was Sergei Pavlovich's strict and demanding nature that ensured conscientious discipline, organization and high productivity. But the more I got to know him, the more interesting and mysterious I found him: I wanted to learn everything about him.

Sergei Korolev was interested in aviation even as a schoolboy. Working with machinists at the Odessa

hydroplane section, he gained an understanding of the complex (for the time) operation of the planes. In 1922 Sergei, still a pupil, presented the Ukrainian and Crimean Aviation and Air Navigation Society with a design for a glider.

After graduating from secondary school, Sergei Korolev enrolled in the Kiev Polytechnical Institute to pursue the study of aerodynamics. Later, he transferred to the Bauman Higher Technical School in Moscow. The light engine aircraft he designed for his graduation work under the guidance of his advisor, Andrei Tupolev, was test flown in 1930.

In his time away from class, Korolev was doing what he had always dreamed of—learning to fly. Before long he had completed flight school and was a pilot.

Together with S. N. Lyushin, a designer and engineer, Sergei Pavlovich constructed the *Koktebel* glider and flew it in six national glider competitions. For the seventh he had a surprise in store—the *Red Star* glider he had designed and built to withstand aerodynamic overloads involved in flight acrobatics. But just before the start of the competition, Korolev fell seriously ill and was hospitalized. Another pilot, V. A. Stepanchenok, performed the aerobatics in Korolev's glider and shared the fame and glory with the craft's designer.

From 1931 to 1935 Sergei Pavlovich developed and proposed a number of original glider designs, one of which, in 1940, was selected to be the first Soviet rocket plane.

In the 1930s Korolev became one of the first directors of the country's newly established scientific research and production organizations in rocket technology. In 1931 both he and Friedrich Tsander were appointed to the Jet Propulsion Study Group. And in May of the following year Korolev was appointed

head of the Group. A year later he directed the launch of the first liquid propellant rocket designed by Mikhail Tikhonravov (an outstanding scientist whose theories on space exploration astounded the leading specialists in the field) and constructed by the Jet Propulsion Study Group.

Sergei Pavlovich considered the research conducted at the Jet Propulsion Scientific Research Institute, known by its Russian acronym—RNII—to be the first stage in the development of rocket technology. Mikhail Tikhonravov had this to say about Korolev's work at the RNII:

"The study of the stratosphere is not the ultimate goal of the development of rocket technology but merely the means for improving and reaching a state of technological development which will make it possible for man to reach the outer layers of the atmosphere and then travel further into space to other celestial bodies."

But despite the experience already accumulated, rocket flight was a distant dream. Nonetheless, Sergei Pavlovich and others like him believed that man would travel into space within the next generation.

Whereas K. E. Tsiolkovsky may be generally considered the founder of theoretical cosmonautics, Korolev and his co-workers must be given credit for implementing and further developing his ideas.

The most difficult time for Korolev was during the years of the war. Though conditions were far from conducive to creativity, he worked on the problem of equipping military planes with boosters. It wasn't until after the war that he was able to really return to his ideas and designs.

In 1946 Korolev was named Chief Designer of the long-range ballistic guided missile programme, and in 1950 he took on the responsibilities of heading

a special design bureau. He put all his efforts into the missile development programme, and already in October 1948, the first Soviet ballistic missile was successfully tested.

In 1951 Sergei Pavlovich and his team were the first in the world to begin biological testing during space flight. In a special container, animals were lifted to a height of one hundred kilometres and then safely returned to the ground.

For his accomplishments in rocket construction, in 1953 Sergei Pavlovich was elected Corresponding Member of the USSR Academy of Sciences. He continued to selflessly dedicate himself to his work and in 1956 was awarded his country's highest honours—the Order of Lenin and the title Hero of Socialist Labour.

By this time a whole series of rockets for geophysic and biological research as well as a powerful launch-vehicle had been designed and developed. Then, in 1957, the first artificial satellite in the history of man was launched, an event which further consolidated Korolev's authority. For his great contribution to the development of rocket technology, Sergei Pavlovich was awarded the Lenin Prize and elected an Academician and member of the Presidium of the USSR Academy of Sciences.

Sergei Pavlovich built up a team of distinguished scientists who were dedicating their careers to achieving manned space flight. The development of the booster rocket was a first step to accomplishing this goal. Even today the incredibly successful venture seems remarkable for the simplicity, originality and reliability involved. It's hard to believe that the booster rocket was designed more than a quarter of a century ago.

Usually, the different aspects of complicated scientific and technological questions are solved

individually by independent research and development and production technology teams. But Korolev favoured the integrated approach, building better spacecraft and simultaneously improving multi-staged boosters for them. He wanted to accomplish as much as he could for his country in the shortest possible period, as if he sensed that he did not have much time left.

After five successful *Vostok* missions, cosmonaut Valentina Tereshkova became the first woman in space. Already by this time a model of the three-man *Voskhod* spacecraft, which would allow the cosmonauts to work without spacesuits and effect a soft landing on ground, had been constructed and was on display at the testing station. Models for lunar probes and other satellites were also located there.

At the design bureau Korolev had set up a unique museum which included exhibits of scientific equipment and systems that had been successfully deployed in space. To facilitate their study, these were all displayed in strict chronological order and kept in a special demonstration room, which became a school for inventors of new spacecraft systems.

"Before you set about inventing the samovar and wasting good time, look at what's already been done," Sergei Pavlovich instructed his colleagues.

After coming up with a new design, Korolev assigned the talented young specialists with the most experience in working on the project to further develop it. Meanwhile he went on to work out new ideas. In this way he created a new engineering design organization with its own technological facilities.

Together with his colleagues, Sergei Pavlovich implemented Tsiolkovsky's ideas, further developing them and laying the foundation for space exploration. A partial list of Korolev's achievements includes: the creation and development of a powerful

booster rocket, artificial earth satellites, probes for the study of the moon, Venus and Mars; the first manned space flight, the first three-seater spacecraft; cosmonaut space walk, soft lunar landing.

The space programme founded by Sergei Korolev was not only concerned with launching rockets but also with the complex system of ground flight control and search and rescue operations. Working together in this area were numerous scientific research establishments, testing organisations and technological work teams.

The developments of the new space age, which Korolev and his colleagues had ushered in, continued to evolve and expand rapidly. Hundreds of thousands of people were involved in this work, and Sergei Pavlovich was in charge of them all. The head of the Council of Chief Designers, he was acknowledged, as M. K. Tikhonravov so aptly put it, a "leader among leaders". He was inundated with work, and sometimes entrusted his young assistants with extremely important tasks. But in matters both large and small, he delegated control to no one.

Korolev's role and position of authority were, in my opinion, best illustrated during preparations for the launch of the newly designed *Voskhod* spacecraft. The *Voskhod* flight programme would differ considerably from that of previous launches: for the first time in history a spacecraft would have a three-man crew. Also, the cosmonauts aboard would effect a soft landing.

Two crews were selected, and their commanders appointed: Vladimir Komarov, an unassuming, likable pilot-engineer, and Boris Volynov. Upon the recommendation of M. V. Keldysh, President of the USSR Academy of Sciences, a scientist from a Moscow scientific research institute was to be included in the crew. The engineers worried that the scien-

tist was too tall, but in the end decided they could accommodate him with a special seat.

Sergei Pavlovich had long considered bringing in skilled engineers to work at the design bureau testing new technology in space. Concerning this proposal he stated:

"Occasionally we will allow specialists working on systems that require testing for workability and reliability during space flight to accompany professional cosmonauts into space. After making such a flight, these specialists will return to their usual work. In this way we will obtain much information that will allow us to move quickly and confidently ahead."

Korolev had a lengthy discussion about this proposal with Yevgeni Fyodorov, a physician who helped recruit cosmonauts. Afterwards he announced his decision to include engineer Konstantin Feoktistov in the first *Voskhod* crew. Later, at a general meeting, Sergei Pavlovich explained the reasons for his decision:

"The flights already conducted have confirmed our initial assumptions: it is possible to engage in fruitful work in space. This, however, does not mean that we have achieved everything. Though up until now things have gone along rather smoothly, the perils of space still remain: danger lurks everywhere. There is much we still do not know and are only in the process of trying to discover. We need facts, facts about space itself, about the operation of the booster rocket and the spaceship systems, about man's physical condition and much else. We must obtain this information with a minimum of expenditure. It is important to remember that each space launch is expensive," here Korolev pounded the table, "too expensive for the state. We must count every kopeck." He paused for a moment and then continued, "This was what I was taught in my time, and I

am now sharing my experience with you. In order to obtain the maximum amount of information from each flight, the time has come to send into space researchers, scientists, physicians, engineers, and journalists." The audience laughed. "Yes, I'm serious. Good journalists and other specialists capable of objectively and eloquently describing space flight."

"The doctors won't allow it," someone in the audience spoke up.

"I think that the doctors will have to change their minds. We must utilize the knowledge of scientists and specialists, and how many of them are in perfect health?"

"We are against this proposal," a voice called out from the door.

Startled, Korolev looked up. He frowned across the table and said in a quiet voice:

"Who is 'we', may I ask?"

A heavy man rose from his seat.

"Our organization will not accept the risk," he announced categorically. "We will not sign the document."

"Have you been authorized to state this refusal?"

"No, but I know the opinion of our specialists. Considering the state of health..."

"Opinions will change with time!" Korolev interrupted. "The situation is improving. We will take your remarks into consideration."

Sergei Pavlovich continued to speak:

"No one has ever before dealt with these questions. As in every new venture, there is a certain amount of risk involved. But our goal is worth it. What we must do is minimize this risk, which is why we plan to include scientists and well-trained specialists in our crews. The selection of specialists will be conducted on a principled basis, strictly according to work ability. There will be no gerrymandering!

As for health requirements, I believe they will be changed, especially since flight conditions have improved and landings are easier."

"Sergei Pavlovich, you mentioned scientists," Yuri Gagarin rose to speak. "We have excellent engineers and candidates of science working with us at the Centre. Is it possible for them to participate in space flights, too?"

Korolev looked reproachfully at his favourite cosmonaut:

"It's possible. But, unfortunately, not all candidates are scientists, just like not all pilots are aces. Many people work in the field of science, but only a few leave their mark. We have been entrusted with responsible work, and we are obligated to leave man a rich legacy."

Korolev had to fight a hard battle but managed to have the representative of his design bureau, Konstantin Feoktistov, accepted as a member of the *Voskhod* crew.

The State Commission, whose members were all experts in their fields, noted the excellent training of the cosmonauts in the first and the back-up crews. Each cosmonaut demonstrated endurance, knowledge and the ability to fulfil his assigned tasks. The final test was a training exercise in the simulator that duplicated conditions of the forthcoming flight, lasting the entire period of time and utilising communications and operative groups at mission control. Again, the cosmonauts did exceedingly well. The next day we boarded a plane for the cosmodrome.

As we stepped off the plane we immediately felt the heat of the Kazakh steppe. Sergei Pavlovich was among the welcoming group that had gathered on the scorching pavement of the airport. There was no sign of tension in his face, so no doubt everything was proceeding according to plan.

The cosmonauts began each work day with calisthenics which they performed under the guidance of special coaches. The cosmonaut team was still young, having been formed less than five years earlier. Nonetheless, certain traditions, humorous as well as serious, had already been established. Sometimes the sound of laughter would echo from the gym: the cosmonauts would place one of their group in a headstand on a handkerchief spread on the floor and count the number of years old the birthday boy was.

Basic technical training took place in the assembly and testing facility and its adjacent laboratories. The cosmonaut crews were also to conduct several training sessions in the *Voskhod* spacecraft. The men had already become acquainted with the ship during the assembling and testing procedures. Now they were to settle into their work spots, test technical devices, arrange and fasten down portable equipment, maps and map cases, logs and instruments. Under the guidance of skilled experts, they tested the functioning of switch systems. The cosmonauts were also asked to try out their reclining seats for comfort and range of motion. Each man had a cushion for his head and body that would be placed in his seat before lift-off.

During the lengthy training sessions Korolev could often be seen standing on the building berth next to the rocket. Through the hatch, he observed the cosmonauts as they trained and talked and joked with them.

Korolev usually watched the lift-off and the first stage of the rocket flight from a bunker near the launch pad.

After the launch, journalists, engineers and members of the State Commission gathered around Korolev to congratulate him on the successful lift-off:

"It's too early for congratulations," he answered

in a preoccupied tone, "the ship still has to land."

Sergei Pavlovich carefully studied the telemetric data and radiograms being relayed from mission control. Aboard the spacecraft everything was proceeding according to plan, and the crew felt fine. But Korolev remained at the control panel, obviously concerned about the mission and the cosmonauts. It was, after all, the first three-man mission, the first without spacesuits, the first soft landing... Soon the spacecraft passed out of the field of observation of the Soviet control stations. Communications with the crew were severed until the next morning.

When they returned in the morning, the members of the State Commission found Korolev just as they left him. An officer on duty quietly informed them that Korolev had been at home for just a little more than an hour.

The tension mounted with each passing second. The *Voskhod* had entered its final and most important orbit where, at the precisely scheduled time, the retrorockets were to be fired. This was to occur on the other side of the world, so there was no communication link. All we could do was wait.

According to our calculations, the appointed time had passed. Everyone at mission control was suddenly quiet. All eyes turned to Sergei Pavlovich, who, though pale and wearing a look of concern, remained calm. A communications worker slipped up to Korolev and layed a radiogram on the table in front of him. Quickly scanning the message, Sergei Pavlovich smiled:

"The retrorockets fired and functioned the programmed time period."

Everyone was suddenly in good spirits, though the most important test was yet to come: the engagement of the deceleration and main parachute systems

that would effect a soft landing.

The waiting seemed unbearable. Finally, a voice came over the loudspeaker:

"A pilot from the search and rescue team has spotted an object with a parachute."

But Korolev still looked preoccupied. He remained sitting motionless next to the loudspeaker, trying to catch every sound. The minutes passed; the spacecraft should already have landed, but there had been no communication. Smiles began to fade, and everyone, once again, turned to Korolev.

Just when our patience had almost given out and it seemed that measures would have to be taken, another radiogram was placed in front of Korolev. Sergei Pavlovich breathed a sigh of relief, leaned back in his chair and smiled. He began to read the radiogram: "Ship has landed on target. Soft landing system worked great. Crew in good condition..." Before he could finish reading everyone had begun to applaud and congratulate each other.

...After a brief rest, Korolev met with the cosmonauts in their hotel to congratulate them on their successful flight and welcome them home. The conversation continued for some time, and the cosmonauts invited him to stay to dinner. Korolev was in good spirits and joked quite a bit at the table. Then he grew more serious and asked:

"What did it feel like when the soft landing system went into operation?"

Vladimir Komarov, whom Sergei Pavlovich had come to respect as much as Gagarin, answered: "We assumed a crouching position and waited. It all happened unexpectedly quickly. There was a slight jolt and then we smoothly touched down."

The cosmodrome seemed deserted after almost all the specialists left with Korolev for Moscow. Occasionally a white-coated figure could be seen

passing between the buildings: the doctors had worked out a whole system of post-flight tests and were busy carrying them out.

The success of the space laboratory aboard the *Voskhod* confirmed the reliability of the spacecraft and its operative systems. Now work could begin on the *Voskhod-2* mission. The cosmonauts selected for the flight would have to have a good knowledge of technology and the flight programme as well as excellent physical health, endurance, and self-control. This time Pavel Belyaev and Aleksei Leonov were chosen. They were to be trained for an unprecedented experiment: a "walk" in open space at the unbelievable speed of twenty-eight thousand kilometres per hour.

Special problems and difficulties arose in training the cosmonauts for this mission, the most serious of which was simulating the flight. Everyone working on the training programme was involved in solving the difficulty. Initially the cosmonauts had been introduced to weightlessness in a two-seater fighter. But the plane's cabin was too small for both instruments and a man in a spacesuit. It was decided to remake the Tu-104 plane into a flying laboratory that could withstand the g-load that occurs when a plane pulls out of a dive.

The passenger seats were removed from the plane, and a model of the interior of the spacecraft, with an air lock, was placed on the floor. An identical model was set up in the altitude chamber.

After the flying laboratory aboard the Tu-104 was operational, the training programme began to move ahead. Taking advantage of the qood weather, the cosmonauts quickly mastered the standard programme and possible emergency variants. As the work was strenuous, the doctors limited the flights to two per day, and later allowed only one.

Meanwhile, Vladimir Komarov and Valery Bykovsky along with their colleagues began to learn about the operation of the *Soyuz*, a new, more modern spacecraft.

The training programme was growing more complex and time-consuming with each flight. The decision was made to create a new position—deputy director of the Cosmonaut Training Centre. Yuri Gagarin was nominated for the post, and he enthusiastically agreed to accept the responsibility. Personally, I was glad to have Gagarin as my deputy. He was broad-minded and could listen to the opinion of others. Though he was a man of principle and knew how to defend his position, he could be won over by a convincing argument. Witty, bright and sincere, he approached his work with all seriousness: he never signed a paper he was not thoroughly familiar with. Often he would tell his subordinates: "A document characterizes an organization and its director."

As soon as he took over his new duties, Gagarin began to study the paperwork. He was well acquainted with the training programme organization and quickly took control of the training of the crew for the *Soyuz* mission and the final stages of preparation for the *Voskhod-2* launch. The training programme for the *Voskhod-2* mission was similar to the *Voskhod-1*, but preparing for the "space walk" made it considerably more complex. Nonetheless, work proceeded in an organized manner and strictly according to plan.

The spacecraft was undergoing its final stages of assembly and verification of systems operation. Sergei Pavlovich would often mount the rocket where, under the supervision of Gagarin, Belyaev and Leonov were already organizing their working places. Korolev watched the cosmonauts as they

worked, talking and laughing with them.

Korolev constantly sought information from the specialists about the functioning of the systems after they had been assembled. If there was the slightest indication that something might be wrong, the system had to be checked again.

"I'll never forget the evening before the launch," Pavel Belyaev recalled later. "Sergei Pavlovich spoke with us a few minutes. His quiet voice and wise advice raised our confidence in the successful outcome of an extraordinarily difficult mission."

The next morning after breakfast and a medical check-up, the two cosmonauts were driven by bus to a special building close to the launch pad where they would change into spacesuits. Meanwhile, at another location also close to the rocket, the State Commission had gathered for the pre-launch meeting. Senior designers reported that all systems were "go", and the Commission gave permission for the launch.

...After a short farewell speech, the cosmonauts mounted to the top of the rocket. In keeping with tradition, they waved their arms before entering the hatch and settling into their seats. Soon the platform was removed from the rocket, and Korolev and Gagarin headed for the underground bunker. Communications were established with the spacecraft, and the two men began to watch what was going on above ground.

Finally the lengthy wait was over: the long anticipated command sounded loud and clear—"Lift-off!"

Usually observers would break into spontaneous applause after a launch. But this time a silent tension filled the air: everyone knew that this was only the beginning.

The members of the State Commission were also present in the bunker. Korolev sat at a table, next

to him, Gagarin watched the control panel. A special map lay unfolded on the table. While waiting for the first report, the members of the Commission could clearly imagine with each passing minute what operation the cosmonauts were performing. Time seemed to drag. And though everyone had been impatiently listening to the seconds tick by on the chronometer, Belyaev's announcement, "a Soviet cosmonaut has entered open space" sounded like a clap of thunder over the loudspeaker and was immediately drowned out by applause. A few minutes later the image of a man in a spacesuit sailing over the earth alongside the *Voskhod-2* spacecraft appeared on the television screen.

For the first time in history and to the astonishment of the world, a Soviet cosmonaut had left his spaceship and was flying over the world at fantastic speed, travelling southwest to northeast over the Soviet Union. An outside television camera attached to the side of the ship monitored his every move. Leonov smoothly moved away from the hatch and then approached once again. Working in a cumbersome and heavy spacesuit, he directed his right hand to switch on the camera at his belt. Everyone at mission control began to congratulate Korolev. His concern was greater than that of anyone else, for he, better than anyone, understood the danger Leonov faced in returning to the spacecraft. Anything could go wrong.

Time passed slowly, then suddenly the sound of Belyaev's strong voice drowned all conversation:

"We wish to inform the Central Committee of the Communist Party of the Soviet Union and the Soviet Government that the cosmonaut space walk mission has been fulfilled. The crew feels fine. All systems are functioning normally. Many thanks for the confidence placed in us."

For the first time Korolev smiled. Breathing a deep sigh, as if a burden had just been lifted from his shoulder, he sat down at the control panel and picked up the microphone:

"This is Twenty," he said. "Congratulations on the successful completion of the experiment. I wish you a safe flight and soft landing."

On one of the orbits, the necessary data for an automatic reentry was transmitted to the spacecraft. The *Voskhod-2* entered its final orbit and then passed out of the communications zone. The members of the State Commission carefully watched the needle of the chronometer, occasionally looking at the flight programme to see what task the cosmonauts were carrying out at that moment.

The precise time came for the retrorockets to fire, after which the ship would veer toward earth and its stages separate. The ball of fire that would form around the spaceship would sever all communications until the engagement of the parachute system. From the moment the retrorockets were fired until landing, the ship was under complete automatic control.

The seconds ticked away. The ships in the ocean tracking the flight remained silent. Korolev stared at the loudspeaker, as if hoping to see something there. Then the calm voice of Pavel Belyaev was heard:

"The automatic system has malfunctioned. Do we have permission to use manual controls?"

The room grew silent. Yuri Gagarin looked questioningly at the Chief, who nodded his head.

"Permission granted," Gagarin relayed in a strong and confident voice.

A few minutes were needed for preparation. Then Gherman Titov took the microphone in his hand and began to transmit number by number the

previously made calculations for manual landing. But there was no confirmation from the spacecraft: the ship had already passed beyond the reach of radio communication. The information had to be transmitted several times.

Why did the automatic system suddenly malfunction after having passed all tests for reliability? Could the sensors have been damaged when the air lock was opened? No one could say, but we did know that it would be difficult to guide the spacecraft manually, especially since the men were in spacesuits. Would the cosmonauts be able to accurately orient *Voskhod-2* when they entered the extra orbit? After all, now they would be landing at a considerable distance from the target area.

"Calculate where the landing area has been shifted," Korolev instructed a specialist. Then, turning to the director of the search and rescue operation, he said: "Get the weather forecast for the area."

Finally we received word that the retrorockets had fired, and a little later got the report that an object with a parachute had been sighted.

Voskhod-2 landed in the taiga. A low cloud cover, snow, thick forest of evergreens and approaching darkness complicated the search for the spacecraft. It was at this time that the cosmonauts' intensive training for emergency situations paid off. Thanks to the skilled action taken by the cosmonauts, rescue helicopters were soon able to establish communication with them and locate the ship.

The daring experiment had been successfully completed. Without exaggeration this was the most difficult and anxiety-provoking flight of all, for both Korolev and the cosmonauts. And in importance it ranked along with Gagarin's flight. The *Voskhod-2* mission showed that man could work outside a spacecraft in the inhospitable conditions of space. This

meant that cosmonauts would be able to assemble large structures in space.

After the cosmonauts had enjoyed a lengthy rest at the cosmodrome, filled out the necessary reports and undergone medical check-ups, they flew to Moscow. The next day at a large meeting of Korolev's design bureau, Aleksei Leonov and Pavel Belyaev thanked the engineers and personnel for designing and constructing the remarkable *Voskhod-2*.

A week later Korolev invited the cosmonauts to his home. There he told them: "You probably don't yet fully realize what that space walk means for science. Your achievement will go down in history."

During their conversation with Sergei Pavlovich, Leonov and Belyaev complained about the lack of communication ties with the earth when the spacecraft left Soviet territory. They said that not being able to hear voices from home made them feel a little uncomfortable.

Korolev's face lit up. "That's a good point. And that's why we're going to establish several orbital research stations." He showed the cosmonauts model ships under glass. "They are going to be equipped with new means of control. These ships will provide us with uninterrupted communication at any point of orbit."

Gagarin, who was also present, expressed his uncertainty: "This is probably something for the distant future."

"No more distant than in another two or three years. We won't be able to continue our work without such ships. You cosmonauts were the first to open the doors to the vast universe. There will come a time when man will explore that vastness, and the whole world will celebrate. You have shown the world that man can live and work in space. The space walk opens new opportunities for science to

use space for peaceful purposes. It will be a difficult undertaking, but one that can succeed. The first steps are always the hardest, but we must make them—both for science and for all mankind.

When the cosmonauts were leaving, Sergei Pavlovich embraced them and said with a smile:

"I envy you your youth and health. There was a time when I, too, couldn't complain." Korolev sighed and added: "Now I'm in and out of hospitals... They told me to come in right away for some tests."

"They subject us to tests almost everyday", Aleksei said, trying to make the older man feel better. "You get used to it after a while."

"It's different with you. You're young and healthy. You haven't had to live through..."

"You're probably just overworked," Gagarin said soothingly. "After a little rest you'll be back to normal. Stop by my place sometime."

"Thanks, I will. As soon as I have the time..."

...Their achievements had been impressive, but Korolev's design and construction bureau and all the laboratories and enterprises affiliated with it did not slow their pace. The work was interesting, and everyone was excited about prospects for the future. Moreover the tasks were precisely formulated, which made it possible to work at a uniform pace.

Korolev was greatly interested in the exploration of outer space and the moon. Lunar exploration had long intrigued him, and one probe after another was sent to collect information and effect soft landings on its surface. Even in the hospital he continued his work in this area.

One day in winter, shortly before his birthday, Sergei Pavlovich, accompanied by his wife, arrived in Star City. Nina Ivanovna remained with our wives while we took Korolev on a tour of a new housing construction area and simulation facilities. Next to

the simulator, where a training session had been in progress since morning, several cosmonauts were quietly talking. Behind the control panel sat instructor Alexander Voronin and his assistant. The training director was sitting behind another desk.

"Comrade Chief Designer, a training session in the *Soyuz* mock-up is being conducted," the director crisply reported after he had caught my signal.

"Very well. Continue," Sergei Pavlovich answered and then walked up to greet the cosmonauts. He warmly shook the hand of a young pilot and asked with a teasing smile:

"What are you doing here on a Sunday? What about your family? Or did they call you in again?"

"Affirmative!" the young man answered.

Korolev's face clouded. He was about to make some pointed remark when another cosmonaut hastened to add:

"He's got it all wrong, Sergei Pavlovich. No one called us in. It's just that we heard you were coming and we wanted to see you."

"I'm not here on official business," Korolev replied. "I won't keep any of you." But no one left.

Approaching the control panel, Korolev stood behind the instructor and looked at the instruments.

"Who's in the ship?" he asked.

"Vladimir Komarov is working on orienting the ship for reentry," the instructor answered.

Sergei Pavlovich pointed to the microphone and asked:

"May I? I won't be disrupting?" When he was told it was perfectly alright, he spoke into the microphone:

"This is Twenty. How do you read me?"

Silence. Obviously Komarov was wondering where the Chief's voice could be coming from. Then he answered:

"I read you loud and clear, Twenty. Over."

"Good morning. How do you feel?"

"Good morning, Sergei Pavlovich. I feel great. Everything is proceeding according to plan."

Korolev wished Komarov luck and then thanked the instructor. He walked into a room where the cosmonauts were waiting and sat down at a table. Making himself comfortable, he said:

"If my memory serves me right, most of you are young cosmonauts. I want you to remember one thing, comrades: the field you have chosen is new and to a large extent unknown. It is therefore difficult, risky and extremely expensive for the state. Anyone counting on easy fame and glory will be sorely disappointed. Anyway fame doesn't care much about the future; it only hinders development. And we must constantly move ahead. We don't have time to sit back and bask in our glory. I advise anyone who disagrees to quit so as not to waste his time. There are others more worthy to take his place."

Sergei Pavlovich paused and looked intently at the cosmonauts who had been listening in silence. He continued:

"Our work must be based on sound knowledge, arduous, daily labour that reveals all human traits, and strong discipline. I understand that you all have a sound education?"

"All the newly recruited cosmonauts graduated from a military academy," I answered.

"What academy?"

"The officers finished either at the Zhukovsky Air Force Engineering Academy or the Military Aviation Academy. After graduation they all did active duty in different positions."

"And how are our 'old-timers' doing on their exams?"

"Just fine, Sergei Pavlovich. Their instructors are pleased with their work. Andrian Nikolayev isn't here now."

"Where is he?"

"In Japan at the moment," Gagarin answered with a smile. "When they gave the aerodynamic exam he was in Italy. He's certainly strong-willed. He takes his notes and textbooks with him when he travels. During the day he tours the country: at night, he studies for his exams. He makes excellent marks on all of them."

"Good for him! There's a man with character," Korolev said enthusiastically. "Let him be an example to the rest of you... Now, is there anything I can help you with?"

"Tell us a little about your plans if you can," Gagarin had raised a topic of interest to all the cosmonauts. "What will we be working on in the future?"

Korolev thought for a moment, as if to gather his thoughts, and then answered:

"Right now we're preparing for the launch of the *Soyuz*, a new spacecraft that is very promising. It has already tested well in unmanned flights. We are also working on a space station. Your comrades have already seen the wooden model. If any of you hasn't yet seen it, I suggest you find the time to do so. We are also working on effecting an unmanned soft lunar landing and conducting research into outer space. At the same time we are still concerned with making all stages of space flight as safe as possible. You'll learn more about the work once you become involved in it."

Sergei Pavlovich paused and then said: "I have a question for your director." Everyone listened attentively. "Is there a general construction plan for the Cosmonaut Training Centre?"

"Of course, " I replied. "We couldn't build without a plan."

I'd like you to make a report on the advantages and drawbacks. Could you do that?"

"Yes, of course."

"I walked around your town today and observed the construction. The first thing I noticed was that there wasn't enough space. And it isn't exactly the best location—there's no room for development. The buildings are well-constructed, but the city layout could be much better. You have only yourselves to blame: you left everything up to the constructors when it's you who will be living and working here. And it's clear that there has been a lack of foresight. Work facilities are being constructed without a thought for the future. But Star City is unique! It should be exemplary."

"You haven't seen it all, Sergei Pavlovich," Gagarin spoke up. "Come look at the swimming pool and gymnasium."

"You want to try to change my mind?"

"No, but you should see the whole picture."

"Alright, since no one has any questions, let's go. As for you," he turned to young cosmonauts, "we shall meet very often. I wish you to have good rest."

Korolev was pleased with the clear water and well-marked lanes in the swimming pool. He also liked the gymnasium. For a while we walked in silence. Suddenly Korolev remarked:

"What wonderful nature you have here. It's really too bad there's so little space."

"It will be enough for this century anyway," someone said with a laugh. "We'll have our work cut out for us just trying to utilize what we have."

Korolev exploded:

"It's not enough to live for the present, young

man. What are we going to leave our children? And their children? Everything that we possess is the talent, work and scientific discoveries of many generations, of everyone who lived before us. It is on the foundation that they laid that we are building our house. Those who come after us will be able to move ahead quickly and confidently if we leave them a worthwhile legacy. Our society is like a multi-stage rocket—constantly moving into the future at a greater speed. It is egoistical to think: 'After us the deluge'."

After lunch, when the cosmonauts began to leave, Gagarin asked Sergei Pavlovich to go to the gymnasium to watch a game. But Korolev wished them good luck and declined. The doctors had reluctantly released him from the hospital and only on the word of his wife that he would soon return.

"I have to be back in my ward by 18.00," he said. "In a few days I'll have to undergo minor surgery."

Gagarin looked up in surprise: "You're going to have to spend your birthday in the hospital?"

"Unfortunately, yes. No one knows about it, and I'm not talking about it. I'll have the operation and a week later, you can all come to my home. We'll sit and talk." Korolev turned to me and said: "Don't come to see me now and don't send anyone."

As he was preparing to leave, Sergei Pavlovich asked Gagarin:

"Why didn't you go to the gym?"

"I have a flight training session tomorrow."

"What are you going to fly?"

"A fighter."

Korolev thought a moment and then asked:

"Is it really necessary? It requires some special training as well as a lot of time to fly these modern fighters. And from what I hear, your time is in short supply."

"I'm a pilot and the deputy director of the Cosmonaut Training Centre. I can't very well teach others if I don't have flying experience myself."

"My dear boy, at one time you were a fighter pilot. But now that you have become the world's first cosmonaut you've probably lost some of your skill."

"I'll regain it and fly as well as anyone."

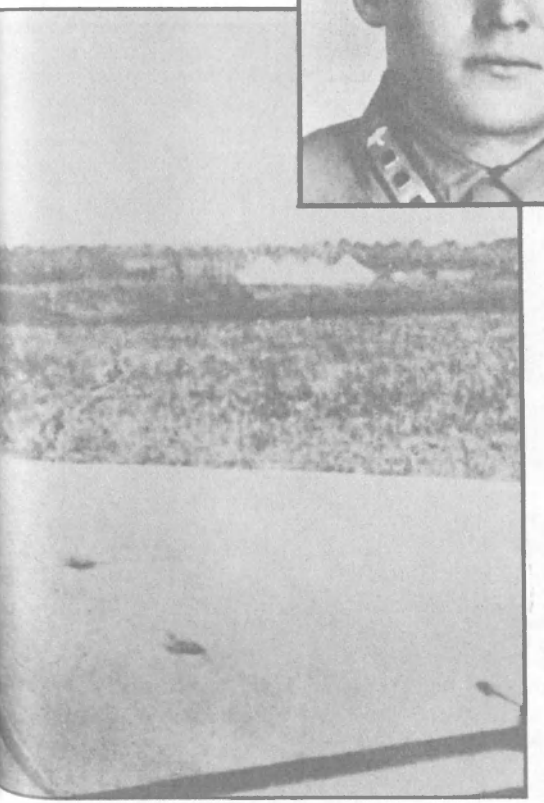
As we said goodbye to Sergei Pavlovich, we joked and laughed and talked about when we'd meet again. We made plans and discussed what we would give him for his birthday. Everyone was lighthearted, no one ever dreamed that we would never again see this wonderful man, the founder of our country's space programme.

Sergei Korolev.
Six years old

Sergei Korolev, graduate
of the Odessa
construction vocational
school, 1924

Sergei Korolev and Boris Cheranovsky next to the BICh-8 glider. Koktebel, 1929

Sergei Korolev, 1928



Jet Propulsion Study Group (GIRD). On the right, Friedrich Tsander; second from the left, Sergei Korolev, chairman of the GIRD Technical Council

"The Red Star" glider, constructed by Sergei Korolev, 1930

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Sergei Korolev working at GIRD

Academician Sergei Korolev

Academician Sergei Korolev and Yevgeni Karpov, head of the Cosmonaut Training Centre, 1961

Cosmonaut trainees together with Sergei Korolev, Yuri Gagarin, Yevgeni Karpov and Nikolai Nikitin, their instructor, May 1961

Academician Sergei Korolev, General Nikolai Kamanin and Colonel Vladimir Yazdovsky, May 1961

Academicians Sergei Korolev, Igor Kurchatov and Mstislav Keldysh

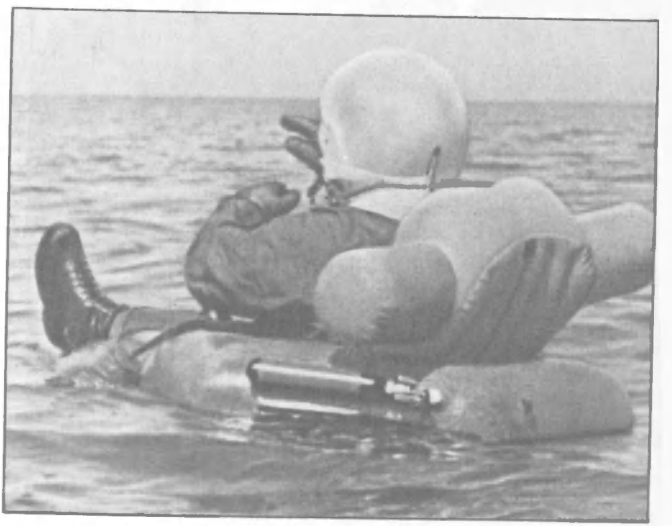
Yuri Gagarin with wife Valentina and Sergei Korolev with wife Nina. Sochi, May 1961

The house in Moscow where Sergei Korolev spent his last years

Korolev's home study

Future cosmonauts at parachute training, 1960

Morning of April 12, 1961. Yuri Gagarin and his back-up, Gherman Titov, head for the launch pad



Yuri Gagarin in flight training. Baikonur cosmodrome, April 12, 1961

Preflight training for a splash-down

Yuri Gagarin and Sergei Korolev. Baikonur cosmodrome, April 12, 1961

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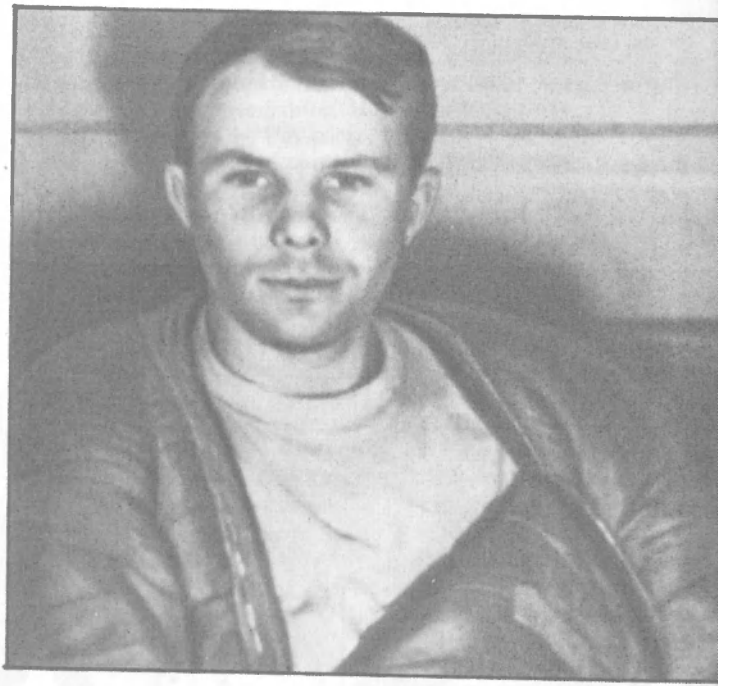
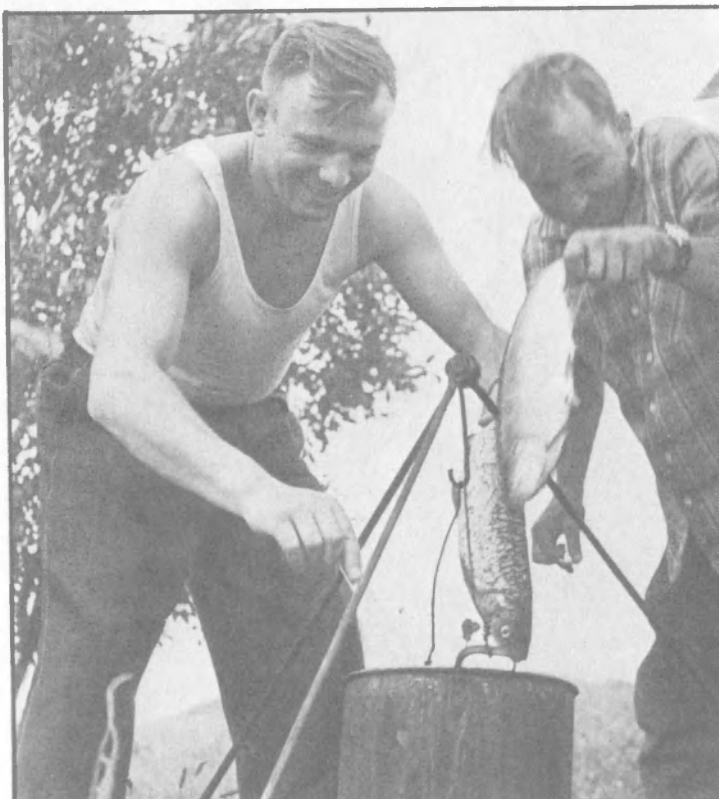


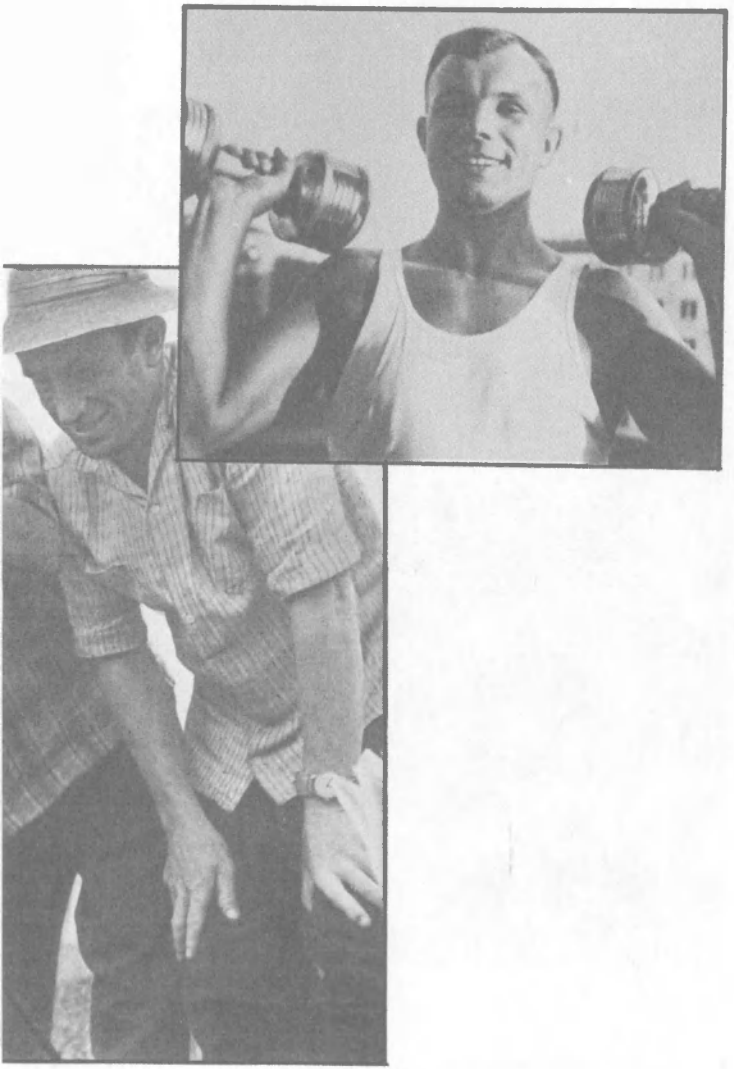
Yuri Gagarin, the first
cosmonaut-pilot of the USSR

Yuri Gagarin, 15 minutes after landing

Yuri Gagarin in Gzhatsk (now Gagarin),
the town of his birth, 1961

Yuri Gagarin, 1961





Yuri Gagarin with Vladimir Komarov

Yuri Gagarin and Gherman Titov, 1961

Yuri Gagarin watches Boris Volynov
during preflight training

Yuri Gagarin Cosmonaut Training Centre

The obelisk at the site of Yuri Gagarin's death in the Vladimir region

Natalia looked out of the window and watched the rain. She felt inexplicably sad. It seemed to her that the drops of rain were angrily dashing themselves against the glass, consciously terminating their own existence, and then sliding downward until they were blown away to oblivion by the wind.

This, then, was how objects ceased to exist. Perhaps it was the same with people.

Natalia thought about the kamikazes, but it was too depressing to dwell on them. She began to think about the romantic knights of the Middle Ages. Her mind drifted to the strong-willed people who had fought in revolutions. This was self-sacrifice of a different nature—not vengeful but idealistic and noble.

The train continued to clatter down the tracks and rumble through the crossings. The rain senselessly beat against the window, making the day melancholy and grey.

A rainfall is never without character. Like people, it has its own voice and colour. And, like people, it is often capricious, coming at the most unpropitious times.

It was freezing in the almost empty carriage.

Sitting opposite Natalia was a pleasant-looking woman who was knitting with great concentration. She probably didn't even hear the sound of the rain, the distressing rumble of the train.

Natalia's eyelids began to feel heavy. She tiredly rubbed her eyes to keep the image of the knitting woman in focus.

The train rumbled on. The wind howled, and a grey haze pressed against the earth.

Natalia rang the doorbell—no answer. For some reason she felt sure someone was home, so she rang again. After the third try, she gave up. She leaned against the wall and cursed her luck before pushing the elevator button.

"Hello."

"Hello," Natalia said, still keeping her eye on the elevator button.

"You rang my doorbell?"

"Oh, I'm sorry! I didn't recognize you, Valentina Ivanovna," Natalia quickly replied as she scrutinized Yuri Gagarin's widow as closely as journalistic etiquette permitted. "Please forgive me and allow me to introduce myself. I'm Natalia Chufarovskaya with *Alye parusa* (Scarlet Sails) newspaper. I've been assigned to write a story about Yuri Alekseyevich."

"Come in," Valentina Ivanovna said, inviting the reporter into her home.

Natalia nervously glanced around and then stepped inside the apartment—Gagarin's apartment.

Valentina Ivanovna was clearly finding it hard to conceal her irritation. She had an apron tied around her waist—Natalia had obviously interrupted her housework. Nonetheless she graciously asked the reporter to sit down. Leaning against the back of an armchair, she asked:

"What do you want to know, Natasha? So much has been written about Yuri that most enterprising reporters work with already published material."

"I want to know everything. How you met, what Yuri said to you... Oh, I'm sorry," Natalia brought her hand to her mouth in confusion. "I didn't mean to be disrespectful."

Valentina Ivanovna smiled. Suddenly, behind the frames of her glasses, the cold, remote look in her eyes was replaced with warmth.

"Everyone called him that. Yuri knew it and didn't mind. I think addressing someone by his first name shows more respect than using the long combination of a first name and patronymic."

"I don't know why I called him that. It just seemed right."

"It's perfectly alright. He has the privilege of remaining forever young," Valentina Ivanovna said quietly and then sat down in the opposite armchair.

"It's not that it's easier to pronounce," Natalia hastened to explain, "it's just that ... how can I put it? It's like I'm talking about an equal, someone my same age, someone in the same dimension... I guess I'm not making any sense."

"I understand. Your feelings for the world's first cosmonaut are yours alone. I don't have the right to be judgemental."

"Thank you," Natalia said. "Would you like me to tell you something about myself?"

"No."

Valentina Ivanovna reconsidered a moment and then said:

"There might be a need for that later." Then, speaking softly, she began to reminisce:

"I remember so many things. Of course the years have dimmed my recollection of some of the details of the past, but it still lives in my memory. I remem-

ber the dance at the military academy twenty-five years ago: the music that could make you feel sad or make you feel like dancing; the shy cadets who bunched together to avoid the limelight. Each young girl who attended the dance had hopes of meeting her prince, meeting her future, as they say. Naturally I had the same hopes. I had no idea that it would be in the form of a young man wearing army boots—a cadet with closely cropped hair, a jutting chin, and flashing eyes.

" 'See you next Sunday,' Yuri said in a confident voice. It never occurred to him that I might not want to see him again. And I must admit that I liked his sense of assurance. I timidly realized that he liked me, that of all the girls there, he had chosen me. He had claimed my friendship.

"In his book, *The Road to Space*, Yuri described our meeting this way: 'We met when they let us out of quarantine. "Bald cadets," the girls at the academy dance called us. She was wearing a plain blue dress and looked shy and modest. I asked her for a waltz, and that was the beginning of our close friendship.'

"But I think our second meeting was more significant. We discovered that our characters were not at all alike: we felt differently about art, the cinema, education, friendship and so on. Neither he nor I tried to hide these differences. We defended our own views, but we didn't quarrel. Later I found that he had his own special appreciation for literature and dreamed of writing a book. As I listened to him talk, I suddenly found myself thinking: this is interesting! I was intrigued with his frank statements and opinions. The time slipped away and I began to look nervously at my watch. Would he want to see me again? After all, we had so little in common.

"The time had come to say goodbye. Yuri summed up our discussion with the words: 'This is great;

it's just what I expected. Let's meet again next Sunday.' Then he looked at my face, as if trying to read my feelings, and said: 'Let's go to your place.' 'To my place?' I asked, trying to conceal my delight. 'Sure,' he replied.

"It had all happened so suddenly that there wasn't time to think. Some girls might have considered it unwise of me to invite a young man I barely knew to my home. But why did he want to meet my parents? When I knew Yuri better I understood that this was one of his most remarkable character traits. He was so easy to get along with and always in control of a situation; he just fit right in.

"Yuri came to see us often. He later told me that he felt at home with my family. And we looked forward to his visits. Soon he was like a member of the family. He could be happy and joking, or sad and despondent, depending on the circumstances. He was attentive, kind, implacable and enthusiastic, but he was never boring. We lived together only a short while: ten years. I don't feel I can say I knew him well. But I probably knew him better than anyone else.

"Writers frequently turn to me for help and become offended when I refuse to be interviewed. But I'm afraid that if I shared my recollections I would lead the writer into my world of personal experiences, and Yuri's memory would be cheapened. Like Aleksei Leonov, I believe that as the years pass everyone who knew Yuri Gagarin well and worked together with him will share not only a feeling of natural pride and gratitude but also a growing responsibility for each word spoken or written about him.

"Each detail of his life, each character trait, each interest that you remember has ceased to be yours alone. It is shared with others, and with each passing year, Yuri is less your friend, your comrade, your colleague—people have a greater and greater need for him."

Valentina Ivanovna dropped her head and for a long while was lost in thought. Natalia closely examined her face: there were wrinkles around her eyes and on her forehead, her features were soft, but her chin was strong. Grief had left its mark on her face, but grief had also formed her character.

"Perhaps you should write your own book about Yuri," Natalia suggested timidly, aware that the advice of a stranger was rarely heeded.

Valentina Ivanovna slowly raised her head. There was sadness and reproach in her eyes.

"It would be too difficult. Yuri's death is still too painful. I can't write about him as if he's a part of the past. They say that time is the best healer. So far it hasn't made things any easier for me. The years have only made me better understand his character, his strength, kindness and perseverance. But in some ways he was always a mystery to me. I never knew what he would say in a given situation, how he would react in unusual circumstances. He was sincere and forceful, never vain or boastful, and he always spoke with intelligence and scathing wit. He never repeated himself, and he never prepared his answers beforehand. Did you want to say something?"

"I want to write a vivid, realistic story about Yuri."

"Well, write it. You're a journalist. You can write a literary biography."

"To do that I must know more about him. His likes and dislikes, that sort of thing."

Valentina Ivanovna was lost in her thoughts. She stood up and took from a cupboard a blue parcel. After looking inside, she turned back around to face Natalia.

"Someone once asked me whom Yuri disliked. I was at a loss for an answer. I thought about it but

couldn't name anyone. He was a man of principle, simple and frank. He was never afraid to stand up to anyone or face an argument; he never tried to be like everyone else. He simply was what he was. He told his friends and acquaintances exactly what he thought of them. He didn't want to hurt or humiliate anyone. But if he felt he had the right and there was a need, he tried to set them straight in time.

"After he graduated from the military aviation academy, Yuri went to serve in the North. I had to stay in Orenburg. He wrote me often, almost every day until I was able to join him. He wrote about everything: the weather, his friends, how he spent his free time, his flying and studies. I could tell by his handwriting how things were going for him and if he was lonely. He missed me as much as I missed him."

Valentina Ivanovna took one of the letters from the packet and began to read:

"Though it's late at night here and darkness envelops everything, it seems to me that I see more clearly. These past days I have thought about and experienced many things. The loneliness (without you) that I feared so much has had some benefit. I will write you about everything. I have come to have a clear perspective about our lives, about our future. I want you to know that everything I do, everything I achieve, I dedicate to you and do for your sake. With you by my side I will endure any trial, overcome the most severe obstacles to my goal. I will spare no effort and never give up what I have chosen. Like no one else, you correspond to my ideal, my views, my dream. My love for you is eternal and boundless."

"Sometimes Yuri would send me poems," Valentina Ivanovna continued. "I knew that he was very moved by them, so I read them carefully, searching

for the echo of his feelings. Everything that he experienced was concentrated in these poems."

She began to read again:

"You will like it here. It's now polar night, and I have not yet seen the entire area. The old-timers brag about their discoveries and say that this is an incredibly beautiful place. There are some problems here, but then every city has them."

"I always answered his letters right away. Sometimes I'd post a letter during the day and then remember something else I wanted to say. That evening, after classes, I would sit down and write again."

"I haven't seen any polar bears yet, and I haven't wandered about in the snow drifts. So I must not be much of a polar explorer. But I must tell you that I've come to know and love this region. Like every military man here, I feel I can say: I have always lived here. They say that when you are with someone you love, the most humble hut is a palace. I believe that. I can't wait until you arrive. I know if I told you to forget your studies and come, you would. And I would be happy, but not for long. Work and the children make your life interesting and full, bring you happiness and a feeling of belonging to a collective. But you must have a profession."

"I love my husband's letters. Unfortunately, I don't have all of them. But those I do have reveal Yuri just as he was: impetuous, passionate and loving.

"I had planned to join Yuri in February 1958. It was a short school vacation and it wouldn't be an easy trip, but those five or six days we would be together promised great joy. Yet it was not meant to be: my father fell ill and I wrote Yuri:

" 'He's sixty-four, which isn't really that old. But he is already an elderly, sick man. Evidently his hard life, the poverty and hunger he knew as a child, the years of farm labour, have taken their toll.

I love Papa dearly and am doing everything I can to ease his suffering. Darling, you must understand and forgive me for not being able to be with you during the holidays. I am with you every minute in my thoughts. I know it is my duty as your wife to be with you. I know how difficult it is for you there in that land of severe cold. But I have another duty as well.' "

"I know Yuri was very disappointed to receive my letter, but he couldn't blame me: children always have a duty to their parents. He tried to cheer me up in his next letter:

" 'My superiors praise me. I don't know if I deserve it; I don't have grounds for conceit. I want to be a real fighter pilot, an ace capable of flying in the most unfavourable weather. I want to fly around the world just like the great Chkalov. But first I want to take off and land at the designated airfield. Unfortunately, the cause of most plane crashes is never discovered. But I have reason to believe that to a large degree we pilots are responsible. I must study very hard to learn the secret of skilful flying.' "

"Yuri's letters were so informative and detailed that when I arrived in the North it seemed to me that I had already been there. It was very hard for me without Yuri. When I was alone I realized what an important role he played in my life. I wrote and told him:

" 'I would go anywhere to be with you. This year without you has been a nightmare. I never want it to be this way again. Never again will we be separated for such a long time. When they learned I was going to join you in the North, they felt sorry for me and advised me not to go and "live with the polar bears". How funny they are. I pity them. Only with you, together, can we reach our desired goal. I will be a help to you, not a nuisance. I know how

much you will accomplish.' "

"And he did accomplish a great deal. But we were often separated, sometimes for long periods.

"I joined Yuri in the summer. We didn't have much time together in the North, but that short period in our lives was memorable and very dear to us. We made a lot of friends there. The word 'North' made us emotional and brought back happy feelings and romantic dreams. Later, pilots from the North would often come and visit us. I could see how eager Yuri was to question them. He wanted to know about everything: the weather, duration of flights, skill of the pilots, hunting and fishing. That would be later, but just after I arrived we started to arrange our living quarters. Our friends helped us to overcome the many difficulties posed by life in the North. They got us a room, furniture and dishes. We were rarely alone—our friends would frequently drop by, and we would sit around talking and laughing. You couldn't live in the North without a sense of humour.

"I'm often asked if I knew that Yuri was training for the space flight. I knew as much as the circumstances allowed, as much as was possible for a wife and friend to be told. I never questioned Yuri about it, because I realized that he would tell me if he could. If not, it was useless to ask. It was his duty to keep a secret, and mine also."

But in all actuality, was there a secret? On June 15, 1958, *Pravda* published "The Realization of Dreams", an article by science fiction writer Alexander Kazantsev that read in part:

"Travel into space aboard a satellite or spacecraft is a dream. But is it a distant dream? It is close and has almost been realized... A spacecraft—sputnik—already circles the earth."

"Yuri was following the same training programme as the other cosmonauts. When he went to Baiko-

nur he didn't know that he would be the first to fly. He often remarked later that all the cosmonauts knew each other well and that any of the six was worthy of becoming the First. Yuri was right: all the cosmonauts accomplished complicated missions in space. To this day I don't know why Yuri was chosen for that first flight.

"In answer to a journalist's question as to how Yuri was selected, Hero of the Soviet Union Georgi Beregovoi replied that the man destined to make the first flight into space must in a certain sense be an emissary of all mankind, a citizen of the world and in all respects worthy of the high title of First Cosmonaut. Yuri's excellent qualities were noticed both by Chief Designer Sergei Korolev and Nikolai Kamanin, one of the men in charge of the Cosmonaut Training Programme, and of course by all the engineers, instructors and many other specialists who participated in preparations for the first launch. In a secret poll, the cosmonauts themselves unanimously selected Yuri as their first choice. It should be stressed that the selection was not made by one or even several people. It was the common opinion formed by many during their joint work.

"It has been said that Yuri's life after the flight proved the correctness of the choice, that his attitude towards work, his relationship with his comrades and his integrity will continue to serve as an example for all Soviet cosmonauts. It's not for me to say if this is so. I do know that Yuri was bothered by a feeling of injustice. 'It wasn't just me; there were thousands of people working on the rocket I flew. And that flight was a triumph of collective thought and work.' "

Valentina Ivanovna spoke with conviction.

Yuri Gagarin's letters! Somewhere she had read that they no longer existed. But they did. Maybe

they contained a clue to the "Gagarin riddle".

The treasure was not buried; it was in a modest blue packet. Gagarin's letters...

"Few people in the world experience the fame, glory and respect that surrounded Yuri. This was why when he returned from his first trip abroad he commented: 'Earth travel is more trying than space voyage.'

"We travelled to many different countries. Everywhere Yuri was shown love and consideration. But he missed Star City. By the third or fourth day he'd be saying he wanted to go home.

"Yuri loved Star City and helped with the construction plans. Each apartment house, each building was discussed, and everyone had an opinion as to what the city should be. Yuri believed that the city of the future should include high-rise apartment buildings, not single-unit cottages. He thought that high-rises would reflect the times.

"Yuri was happy in Star City. He would get up early, exercise and take a shower. No matter how busy his day, he always found time for his daughters. He played with them, showed interest in their activities, discussed their plans.

"Each time he made a trip, whether abroad or in our own country, Yuri would carefully prepare himself beforehand. He studied the itinerary, thought out his speeches and went over the programme arrangements for meeting scientists, workers and servicemen. He was always worried that he might disappoint the people's expectations, and often turned to others he considered more knowledgeable for advice.

"I frequently accompanied Yuri on his trips. I could objectively observe his meetings and speeches in the strange country. Despite the extensive preparations he made prior to a trip, which included stu-

dying the history, culture, traditions and contemporary life of the particular country, sometimes an unforeseen situation would arise that demanded all of Yuri's good judgement, tact and political wisdom. But Yuri also prepared for his travels by reading the works of Tsiolkovsky, Korolev and Keldysh. He especially loved Tsiolkovsky and read his biography several times, always discovering something new of interest in it.

"Yuri read Tsiolkovsky with passionate zeal, with an unquenchable thirst. If he came across a previously undiscovered work, he put everything else aside and read it. Sometimes he would read me passages from his favourite author. I remember his amazement to find a passage in the book *New Conclusions* where Tsiolkovsky writes that the cosmos has been proved to be integral, endless and life-sustaining, and that higher life forms existed throughout the universe. Yuri couldn't believe that the book had been written in 1928."

Natalia remembered reading that Gagarin had been an ardent admirer of Tsiolkovsky. He had wanted to discover the reason for the scientist's optimism, why he was so certain that intelligent life existed elsewhere in the universe and that human reason was all-powerful. It must be remembered that during the latter years of the nineteenth and the early twentieth centuries, European intellectuals were generally pessimistic and tormented by their impotence to cope with the catastrophic events that threatened the continent: the approach of the First World War, foundering economic situation in many countries, widespread unemployment. Both scientists and science fiction writers felt oppressed by the dire economic conditions and lost all faith in human reason and its ability to overcome the state of emotional and economic depression. Predictions of a cosmic cataclysm

and the end of the world were heard more and more frequently.

Then, suddenly, amid this chorus of doom, the Russian scientist Konstantin Tsiolkovsky proclaims his belief in the unlimited development of man and even predicts that in the not too distant future man will begin to explore the solar system.

Tsiolkovsky stated that based on the study of life as a form of movement of matter, it was possible to assume the existence of other inhabited worlds in the universe and that all phenomena and processes in the universe were so interconnected that, "our lives are more cosmic than terrestrial since the cosmos is endlessly more significant than the earth in volume, mass and time."

Natalia's thoughts were interrupted by the voice of Valentina Ivanovna:

"Yuri believed there were many worlds in the universe and that there were other civilizations. He was keenly interested in the search for rational beings and read everything he could about extraterrestrial life. He often spoke to me about his own speculations and enthusiastically defended his views. Later I realized that he had been greatly influenced by the works of Tsiolkovsky.

"Yuri knew that he would never have been able to travel into space had it not been for the research and discoveries made by previous generations. In his many speeches he never failed to mention Kryakutny, a minor official in eighteenth-century Russia and the first man to fly in a balloon, and also the names of such great scientists as Mikhail Lomonosov, Dmitri Mendeleyev, Konstantin Tsiolkovsky, Igor Kurchatov, Sergei Korolev and the famous pilot Valery Chkalov.

"Yuri loved to read and collect books for our home library. It was a great pleasure for him to

meet writers. He spoke with them for hours, asking them detailed questions about their work and new books. We have a great number of books, most of which were presented to Yuri by the authors. Yuri took books with him whenever he had to travel and kept them in his office.

"Yuri's friendship with writers developed soon after he made his flight. I seem to recall that on May 4, 1961, he was invited to the Central House of Writers, where he was met by Konstantin Fedin and Georgi Markov. Yuri was very impressed with these two men and the other writers he spoke with. He often repeated the words of Mikhail Sholokhov:

" 'Yes indeed! That's all you can say. For you are speechless with admiration and pride before your country's fantastic success in this unusual sphere of science.' "

"Yuri was very excited after meeting Fedin and Markov. I could understand his feelings. After all, it was the first time he had ever met any writers, much less such famous authors. He always remembered what Konstantin Fedin said to him: 'I can't even imagine what word would describe your emotion that day.'

"It was at a meeting with writers that Yuri met someone else from his native Smolensk—Alexander Tvardovsky, who presented him with a poem entitled *Horizon Beyond the Horizon.* When he was telling Yuri goodbye, Tvardovsky said, 'Don't get conceited, Yuri. Stay just as you are. Remember we're both from Smolensk.'

"Yuri jokingly replied: 'What are you talking about? Can that happen to anyone from Smolensk? Life isn't long enough to break the rules.'

"Tvardovsky promised to send us all the letters, telegrams and postcards that had been sent to the Writers' Union Board of Directors and the editors

of the newspaper *Literaturnaya gazeta.* He kept his word. We were amazed by the number of letters and cards we received from Soviet and foreign writers, some of whom were very famous. We considered it a great honour to have these poems, speeches and article clippings dedicated to the event of April 12, 1961.

"Yuri was very moved by the way writers celebrated his flight and the attention they paid him personally. But he also realized that the interest would be only fleeting until the time when science began to try to unravel the secrets of the universe.

"It was easy for Yuri to get along with writers, and he never hid the enormous amount of respect he felt for them. He himself tried his hand at writing poetry while studying at the aviation academy.

"The editors of newspapers and magazines often requested that Yuri write for their publications. After the novel *Cosmonauts Live on the Earth* by Gennady Semenikhin was published in the magazine *Moskva*, Yuri expressed his admiration for the magazine staff, praising them for their interest in the space programme. He even invited the journalists to Star City, promising to give them a ride in the centrifuge. When the editors asked him to write an article for the journal or give an interview, he immediately agreed. But due to his heavy work schedule he was unable to fulfil that agreement. He felt guilty for letting the journalists down, and managed to persuade a few of his comrades to write articles instead. Gherman Titov, Yevgeni Khrunov, Georgi Beregovoi, Pyotr Klimuk and Pavel Popovich all wrote for the magazine.

"After Yuri's death, *Moskva* published a sequel to Semenikhin's book. I read it and couldn't hold back my tears: these were the very pages the author had read to Yuri, who had volunteered to help him

with his work. The magazine helped to preserve the memory of the first cosmonaut. In its efforts to immortalize the feats of Soviet people in the exploration of space, it started a new literary tradition. Among those who contributed to it was writer Mikhail Alekseyev.

"Yuri did not know Alekseyev personally. But I remember that one cold winter night in the North he began to read to me from a book by an unknown author. I suppose it's not very fashionable to read aloud anymore. But I did enjoy it. I was then expecting our baby. Wrapped up in my husband's fur jacket, I lay on the couch listening to his voice. I closed my eyes and listened not so much to the words as to the sound of his voice. I wanted nothing more than the trust and respect of my husband. My well-being depended on his love. He suddenly stopped reading, and I opened my eyes. 'Are you tired?' he asked me tenderly. 'No, I'm listening,' I told him. And I wasn't lying. I was listening to the sound of his voice, listening to his sincerity and warmth. I thought about our life together and the baby. 'He writes very well,' Yuri commented. 'You know, our language is really very rich. This colonel is going to be famous soon.' Then he began to read again.

"Years later when I was reading *The Cherry Pool* by Mikhail Alekseyev, I realized that this was the book which Yuri had read to me during those nights in the North.

"Yuri was very impressed with Mikhail Sholokhov. They talked about many things and their conversations were always very educational. The evening they met, Yuri was the centre of attention right from the start. There were many writers from Bulgaria, Hungary, the GDR and Poland present. Sholokhov questioned Yuri about his flight, space exploration, and the Cosmonaut Training Programme. Then he

told him that he envied the cosmonauts and suggested that they write about their experiences.

"For Mikhail Sholokhov, Yuri was a representative of a new generation, an individual who embodied that generation's best features. Yuri understood this, and though he was nervous speaking with the great writer, he didn't try to impress him."

Natalia suddenly looked at Valentina Ivanovna's expressive and graceful hands. She knew that hand movements could sometimes reflect a person's mood and character.

The clock struck noon.

Valentina Ivanovna started, as if awakening, and looked expectantly at her guest. Her routine of cleaning, washing and letter-writing had been disrupted.

"May I help you?" Natalia asked.

"No, of course not. Besides you have other work."

Natalia was disappointed and said apologetically:

"I didn't mean to take up so much of your time. I know memories can sometimes be painful."

Valentina Ivanovna was standing by the bookcase. "How long will it take you to write your story?" she asked.

"As soon as I've collected all the material."

"And how long will that take?"

Natalia felt uncomfortable. She had already decided today that she had chosen the most difficult profession in the world and that she was a failure at it. A modern journalist had to be a little bit of everything: knowledgeable, well-read, clever, and witty, and have the skills of a diplomat, weightlifter and boxer. Perhaps a man might possess all these qualities, but not a woman. She felt as if she were manoeuvring obstacles while she raced down a ski slope.

Natalia had kept silent too long. She knew her hostess was waiting for her answer. "How long will

it take?" she repeated *Valentina Ivanovna's question*. "I'd like to finish today."

"Today? Well, we can try. I think we can do it." And once again Gagarin's widow began to reminisce.

"The tragic death of Vladimir Komarov in April 1967 was the first fatality in the space programme. All the cosmonauts, including Yuri, understood that space exploration was fraught with danger, that casualties were almost inevitable. But Yuri found the reality of Komarov's death hard to accept.

"Vladimir was buried by the Kremlin wall in Red Square the day before the May Day celebrations. Moscow was already festive with bright red banners and flags waving in the brilliant April sun. Now—*black crape*. The colours of joy and sorrow—side by side.

"Yuri tried to comfort everyone, especially Komarov's widow and children. He controlled his emotions and only at home showed how hard he took the death of his friend. Before they buried the cosmonaut, Yuri made a vow: 'We swear we will learn to fly the *Soyuz*.'

"And they did. The *Soyuz* missions were successful and a tribute to Soviet science. Yuri used to keep track of various records set during manned space flights and was proud that the Soviet Union held all the records in the one-man spaceship class.

"From the very start Yuri got along well with all the pilots in the first cosmonaut detachment. I have often been asked why he held so much authority among the others. This is a question I have never been able to answer. Yuri was never ingratiating. He wasn't searching for fame or glory. He didn't try to avoid it, but he believed that those who were worthy would achieve it. And he didn't include himself in this category.

"As a child he knew what it was like to be hungry

and cold. And he went to school in hand-me-down clothes. It was during and after the war, and times were hard for everyone. Yuri was naturally gifted, but it wasn't until later that he was able to develop his talents.

"He wanted to acquire a skill, so he attended a vocational school. The country spared no efforts to encourage and assist its youth—the new work force. Yuri learned to work in a collective and had genuine respect for the work of others. He was totally without vanity and never tried to issue commands or make himself a leader. He always showed respect for his comrades and placed a high value on friendship. These were the qualities he admired in others, and they were the only ones he valued. He didn't care at all what someone's job or profession was. Yuri was always capable of seeing a man for what he was.

"It has often been written that Yuri was always willing to help his friends. He was and he did. But they, too, offered him their assistance. It was a mutual relationship.

"Yuri was strongly impressed by the extraordinary men in the first cosmonaut detachment. I remember that he admired Gherman Titov for being so well-read, Pavel Popovich, for being so sociable, Andrian Nikolayev, for his strong character, Valery Bykovsky, for always being so friendly, Aleksei Leonov, for his artistic talent, and Georgi Shonin, for being such a fine athlete. When Georgi Beregovoi, a wonderful test pilot and fearless ace in the war, joined the detachment, Yuri was elated: Beregovoi's presence raised the moral atmosphere of the collective even higher.

"After Yuri made his flight into space, Aleksei Leonov presented him with a painting he had drawn from Yuri's description. Yuri found it hard to believe

that someone could so accurately paint the colours of the universe without ever having seen them. 'Thank you, Curly,' (Aleksei's nickname) Yuri told him. 'You have great talent to be able to envision what I was unable to find words for.'

"Yuri often spoke about Leonov's talent, about his aesthetic influence on his friends. Despite his busy schedule, Aleksei found time to put out two wall newspapers (*The Syringe* and *Neptune*), draw friendly caricatures and prepare humorous good wishes for special New Year's editions of the newspapers. Leonov's paintings hung in almost all the cosmonauts' apartments. Yuri said that Aleksei could depict both the subtle colours of the earth's iridescent halo and also the distant stars in his paintings.

"Cosmonaut Andrian Nikolayev greatly admired Yuri for his leadership qualities. He once said that Yuri's talents as a strong commander, organizer and psychologist seemed to grow with each passing year.

"Yuri came to know many famous people who greatly influenced his life. But there was one with whom he had a special relationship, one for whom he felt filial loyalty and respect. Sergei Pavlovich Korolev had a father-son relationship with all the cosmonauts and supported and assisted them in every possible way. He was a very well-educated man and advised Yuri to study science and write his dissertation.

"Space flight is complicated and risky. But if you ask any cosmonaut: what is more difficult, preparations on land or the flight in space, you'll get pretty much the same answer: both are difficult. Flight preparations require concentrated effort and painstaking work; the flight itself is the culmination of those preparations.

"I can't explain how Yuri found the time for all

his many responsibilities: he was a member of the school Parent Committee and the head of the technical commission for the Waterskiing Federation, a member of the Komsomol Central Committee and chairman of Soviet-Cuban Friendship Society, he wrote books and gave speeches over the radio, he fulfilled his duties as a deputy and party member. And he still managed to read, study and play with his children."

Natalia was dusting, listening to Valentina Ivanovna's story. Natalia knew this was a once in a lifetime opportunity. Valentina Ivanovna would not want to be troubled again.

Mechanically she dusted the crystal vase—a present from the government of the Czechoslovakian Socialist Republic. It was a beautiful, unique work of art. Natalia was fascinated with the way the vase reflected the light of the chandelier in the hall. She turned it in her hand ... it slipped. She could have caught it, but instead stood transfixed in childlike distraction and watched it fall.

"Yuri was a wonderful family man who adored his children. They had an exceptional relationship of trust and love. Play would easily give way to serious discussions about behaviour, duty and respect. Yuri didn't have any special training as a pedagogue, but his intuition served him well. He was playful with them, but took their actions and words very seriously. The children loved him very much. I think they even felt closer to him than to me.

"Yuri didn't spoil the girls, but he often brought them gifts, usually books. They would read a new book together. I remember that after reading a collection of Pushkin's stories, Yuri took a liking to Russian folk tales. Later he and the girls read aloud the stories of Nikolai Nosov. I was forbidden to inter-

rupt them with a call to dinner or to suggest that the girls go outside to play. Other times they would horse around, play outside or go for a ride in the car.

"Yuri liked to hear his daughters sing and sometimes asked them to perform before company. The girls would do anything for their father and were never shy about singing. Yuri recorded their voices but only rarely listened to the tape: it was too special.

"When the girls were older, Yuri read them Konstantin Tsiolkovsky's autobiography. At first I didn't understand why he chose the chapter dealing with the author's life from the ages of eleven to fourteen. *It is here that Tsiolkovsky states: 'My deafness makes* my biography of little interest, for it has deprived me of social contact, observations and sharing. My biography contains few descriptions of people and events. It is unusual: the biography of a handicapped man.'

"Much later when I carefully reread these lines, I realized that Yuri had been discussing with the girls such serious topics as willpower and humanitarianism.

"Yuri was extremely honest and open with his daughters, and always kept his word. If an unforeseen circumstance prevented him from fulfilling his promise, he would be sincerely apologetic and set a later date.

"The girls asked his advice about everything: what to read, what mittens to wear, what birthday present to give to a friend. Instead of telling them what to do, Yuri would ask: 'What do you think?' and patiently discuss the issue with them. He was not a strict parent: he never punished his daughters and considered mischief to be a part of growing up.

"Yuri loved the outdoors, fishing and hunting.

Communing with nature was one of the great pleasures in his life. He wanted to share his love of nature with his daughters and often took them to the forest.

"One of Yuri's most endearing characteristics was his ability to show affection and concern for those he loved. He always did everything he could to help his parents, showing his love and respect for them in more ways than just material support. Even after he had become famous and thousands of people listened to what he had to say, he continued to respect the advice and wishes of his parents. His mother, Anna Timofeyevna, exemplified industriousness, sincerity and goodness. She was uneducated herself, but her motto, 'Do as I do', was the best lesson she could teach her children. She believed in the principle of hard work. Her lot, like that of many Russian women, was not easy: housework, children, and all too soon, the monotonous routine of widowhood.

"Yuri often travelled to Gzhatsk for two or three days whenever possible to visit his relatives. He was on friendly terms with all the neighbours and felt right at home sitting around a table with a group of workers. Informal discussions would arise in which Yuri would talk about space exploration and his life and that of the other cosmonauts, and also listen to the comments of others. Yuri was happy that almost everyone called him by his first name. It embarrassed him to be shown too much attention and admiration.

"Yuri dearly loved his sister, Zoya, and brothers, Valentin and Boris. They often got together and reminisced about their childhood until after midnight. Yuri was equally affectionate with his nieces and nephews. He used to bring them surprises and gifts, exactly what they had always wanted. Sometimes he wrote them letters filled with friendly advice and

good wishes. When he saw them, he would dance, sing and play games with them, as if trying to compensate for the hardships of his own childhood.

"I continue to receive many letters from people concerned about the welfare of the Gagarin family. The letters come from workers, farmers, writers, journalists, artists and pupils. But the pioneers are especially good about writing. Children are so special. They will not tolerate deceit and keenly perceive good and evil.

"Yuri felt a special friendship for the Komsomol and Pioneer organizations. He seemed to draw energy from these young people and was infected by their optimism. He talked to them about flying, his work, and the new discoveries in space exploration. And he also listened to them.

"I remember how anxious Yuri was when the authorities were deciding if he should be allowed to fly. Some thought that he should be protected from the risk. But if you had known Yuri... He had a mind of his own and always finished what he started. Flying was his whole life.

"When I tried to soothe him he turned to me impatiently and asked: 'How can I train others for flight if I can't fly myself?'

"So Yuri began to fly...

"In March 1968 I was hospitalized. I wasn't depressed about it, but of course it was difficult to leave my children. No one can take a mother's place. Yuri was enthusiastic about his work and was enjoying flying. He talked about another spaceflight and began to train for it. Everything seemed to be going well for him; there were no problems.

"Yuri came to visit me often, bursting into the ward with irrepressible energy and bringing with him the humid smell of spring. He brought me presents and lovingly showed his concern.

"It isn't easy to be the wife of a world-famous man. Whether they mean it or not, others, with their unbridled adulation, take him away from his family, wife and work. Yuri himself was uncomfortable with his fame and popularity, after all, glory is not something one can become accustomed to or prepare for. Sometimes it seemed to me that Yuri was becoming less attentive and loving towards me. When I told him of my fears, he looked at me apologetically and said: 'It's my fault, Valya. Please, forgive me.'

"Yuri's birthday is March 9. I very much wanted to be home, to invite some people over and bake a cake. We always liked to celebrate at home, with the family and friends. Early spring is a time when nature is awakening, when everyone feels more friendly, kinder. But that year we were not able to do it. Who could have known that it was to be Yuri's last birthday, that we would never celebrate it with him again.

"Yuri returned from a travel assignment on March 10 and immediately called me at the hospital. He asked about my health, and I, about his mood. He wanted to come and spend the evening with me, but I told him the girls needed him more: they missed him terribly when he was away.

"I slept poorly that night and woke up feeling worse than before. The doctors noticed my relapse and poor appetite but didn't prescribe any additional medication. I was a medical worker myself, and this negligence upset me.

"Yuri came earlier than I expected. I began to question him, but he just said, 'Later'. Then he leaned over and whispered: 'Let's beat it.' I couldn't find it in myself to scold him for being so childish. It was a wonderful, sunny, spring day, and I gave in to the temptation, even though I was the one who always strictly adhered to medical advice.

"As we drove down the wide Moscow streets Yuri told me how much the girls missed me. My sister had come to care for my daughters at home. But I was always worried that she wouldn't be able to manage both them and the housework. What else could a sick woman and loving mother think? Lots of women believe they are the best housekeepers, the most concerned mothers, the most loving wives. Several days later when I was home I found the house in perfect order, and the girls claimed that they had never eaten so many good things. Everyone in Star City had helped look after them, giving them treats and presents.

"But that day as Yuri and I were riding around Moscow, I began to impatiently ask him to tell me more about our daughters. Yuri looked at me and said: 'I forgot to tell you. Sharik bit Lenka, and the veterinarians think he has rabies. And Galka sprained her ankle skiing.'

"I didn't ask any more questions. He, of course, was just as concerned about the girls as I was. Yet I had been claiming some kind of a monopoly. I asked him to forgive me.

"We began to talk about his work and plans for the future. He told me he would soon begin to fly. This had always been his dream, what he lived for. Whenever he talked about flying, I gave him all my attention.

"So as not to distract Yuri from his driving, I looked straight ahead. The streets of Moscow had been dried by the spring sun, and the feel of spring seemed to have stimulated the drivers: they sped up and down the streets, blowing their horns and adding to the joyous symphony of the day.

"Yuri stopped the car in Revolution Square, got out and bought a whole basket of flowers. He placed them on my lap, pleased with the impression he had

made, and then headed the car for Ring Boulevard. Yuri loved Moscow and knew all the quaint spots and side streets. The Boulevard was one of his favourite streets. 'In April, when you're well, we'll go to America,' he told me.

"I wasn't too surprised. Yuri often travelled out of the country and had already been to America. I recalled how excited he had been when preparing for his trip to England (he had been invited to that country by the executive committee of the Foundry Section of Amalgamated Union of Engineering Workers). He had diligently studied the country and analyzed all the unforeseen events that had occurred on his previous trips abroad. And now he was preparing to go to America again.

"We stopped to have lunch in a restaurant. Yuri talked about the girls and gave me the presents and letters they had sent. Lena wrote about school and skiing; Galya sent me a picture of the rabbit she had drawn. There was lots of news: Yuri told me about his parents, about his visit to Sergei Pavlovich Korolev and his training. He went into considerable detail, apparently trying to take my mind off my illness.

"I wasn't really that sick, but the doctors insisted that I take a cure. Yuri had agreed, but now he wished that I was back at home. The doctors were recommending that I follow a strict diet and stay in hospital for some time.

"I asked him about the speech he was to read at a ceremonious celebration of Maxim Gorky's centenary. He pulled it out of his pocket and read it to me. I thought it was good but a little too elevated and suggested that he tone down the rhetoric.

"Yuri took my comments seriously and began to study the speech. I didn't know then that I would be the only one to ever hear it.

"We returned to the hospital and quietly walked to my ward, trying not to be noticed. But the doctor on call suddenly appeared, and Yuri began to apologize for taking me out, explaining that he had just wanted to show me Moscow in spring. The doctor smiled and said that it had been such a fine day that they purposely left the door open.

"It was hard to say goodbye; we hadn't had enough time to talk. Yuri would not be coming the next day: he had preflight exercises for his flight the following day. Somehow I had to make it through the next few days.

"The day of Yuri's flight I thought of him: the take-off, the mission, the landing. He phoned afterwards and excitedly told me all about it. I understood his excitement and listened without interrupting. It seemed that his break in flight training had not affected his ability. When he finished describing his day, I asked him to try to spend some more time with the children. He had been travelling so much that they hardly ever saw him. Yuri agreed to spend every free minute he had with his daughters, to take them to the movies and for walks in the forest. Then we agreed they would come to see me on March 17.

"They burst into the ward, laughing and talking, with packages and flowers. The girls ran to kiss me and both began talking at once, each demanding my attention. A half hour later they were hungry. I suddenly thought: 'What if he hasn't brought anything to eat?' The time Yuri would have to spend buying something to eat would be time away from us. But Yuri smiled and the girls clamoured even louder that they wanted to eat.

"Yuri began to pull things out of his bag: carefully wrapped meat pies, baked apples, fried chicken, homemade cranberry juice and even hot meat dump-

lings. The appetizing food was laid out on the table, bed and chairs. But the girls, impatient as they were, held themselves back, looking expectantly at me. They had a surprise for me: they had prepared all the food themselves. I praised them for their culinary talent, and they smiled, pleased by their accomplishment.

"Yuri talked about Star City and how much Sergei Pavlovich Korolev was missed. I think Yuri meant not only the Chief Designer's contribution as a scientist and his unswerving dedication to the ideas of Tsiolkovsky, but also his great optimism, willpower and organizing ability. Yuri told me that some scientists were predicting that by the 1970s there would be plasma engines and a lunar space station where several cosmonauts could work. By the 1990s they envisioned building such a station on Mars.

"The girls were playing, but stopped to listen to their father as he talked about the far-reaching plans for space exploration, about flights to other planets in the solar system, a landing on Jupiter, flights taking generations in time, the colonization of other planets... Fascinating prospects.

"I wondered why Yuri had chosen this time for such a discussion. It seemed to me he was preparing me for something. I knew that he was eager to make another space flight, so I assumed he was being given that chance.

"Yuri and the girls left in the afternoon. Yuri had a flight on March 19, and we arranged to meet on the 21st. Earlier that day, he was approached by the director's secretary, Galina Koroleva, who asked him to autograph his picture as a birthday present for her daughter, Natasha. Yuri asked the woman the date of Natasha's birthday, and she replied: 'April 1'. And that was the date he wrote: April 1, 1968.

Natasha was to have an autographed picture of a man who would no longer be living.

"Do you have any children?"

The question startled Natalia, who was already deeply engrossed in her hostess's recollections. But she understood why Valentina Ivanovna had asked it. Children distract you from your grief, help you to seek oblivion; children are an indissoluble link with the past, our hope for the future.

"Yes, I have two."

"That's good. And you're so young."

Natalia had prepared some questions for the interview, but she wondered if she would ask them. Perhaps she was purposely avoiding asking about routine matters.

"Is it hard with the children?" asked Valentina Ivanovna.

"Yes, but it would be harder without them."

"Do you think conflicts between parents and children are inevitable?"

Natalia answered immediately: "Yes."

"Do they exist in your family?"

"Yes."

"How do you settle them?"

"By compromise."

"Do you think that's right?"

"I don't know. Time will tell."

"Have I tired you?"

"No, I find it very interesting."

"And has it helped?"

"I think so. Shall we continue?"

"On March 21 Yuri was told he could bring me home for a few days. He and the girls came to pick me up. We rode around Moscow for a couple of hours and then headed for Star City. At one of the

intersections Yuri ran a red light. A militiaman with a weathered face stepped up to the car. Yuri apologized and handed him his license. The militiaman studied it carefully and looked into the car with a stern expression. Then he returned the license and Yuri apologized again, explaining that he was bringing his wife home from the hospital.

" 'Don't worry about it, Yuri Alekseyevich,' the militiaman replied, his face still serious. 'Drive as you please, as if you were in space. It's our duty to protect you. We all have our job to do.'

"Yuri turned my homecoming into a party. My sister and other guests were waiting for us at home. I walked around the apartment and stopped by Yuri's desk. I began to read the speech he had started to write for a UNESCO conference. I remember he wrote that it was the nature of man to strive to explore the unknown, to learn about his surroundings. And that this was the key to man's constant, limitless development.

"Yuri would never deliver that speech. Several months later, at the request of the director of the Cosmonaut Training Centre, I gave it to the Star City museum.

"Nothing unusual happened the day I was home. Our friends came to visit, asked me about my health and talked about Yuri's birthday. Yuri thanked me for the hunting rifle I had given him. It was the last time we were together. Now I look back and try to recall every detail. Yuri gave me a wonderful day.

"On March 28 some people I knew well and respected came to the hospital. They stood by the door, unable to break the news to me. I was a pilot's wife and knew under what circumstances a superior officer and friends paid an unexpected visit to the family of one of their own. I didn't even greet them.

Seeing their pale faces, I broke the terrible silence: 'Something has happened to Yuri?' They nodded. I still maintained control and heard myself say: 'It can't be!' I refused to believe that Yuri was dead. 'When?' 'Yesterday.'

"I closed my eyes but immediately opened them, afraid I might lose consciousness. My doctor was in the ward and I asked him to discharge me. I turned to the military officers to tell them I wanted to leave right away. They stood there, motionless, with tears in their eyes.

"I tried to stand but fell back in my bed. Something had to be done, I had to leave. Yuri was gone! How was it possible?

"I managed to pull myself together in the car. A nurse gave me a shot and administered smelling salts. The convoy of cars sped towards Star City.

"Some months later the cosmonauts would write in detail about Yuri's last day."

Natalia had heard several versions of what had happened, some contradictory. No one could believe that Gagarin was dead. They wanted to think it was a mistake, even a bad joke.

The adults were the first to understand the tragedy and cry. The young were griefstricken as well: Gagarin had been their banner, and a banner always flies.

Everyone wanted to know the truth: how it had happened, under what circumstances...

The residents of a collective farm in the village of Novoselovo heard the explosion and ran into the office of farm director Ivanov.

"Send a tractor to the crash site! Make an emergency call to Moscow! Send some skiers into the area!" Ivanov placed telephone calls and answered

them, but he himself had no idea who was in the plane. He only hoped it wasn't too late.

Planes and helicopters flew in low over the area until they spotted a big crater in the forest. The crash site was cordoned off and searched thoroughly. The men even brushed away the snow with their hands. They kept looking...

Why had the accident occurred? Engineers were convinced that the engines were operating and the position of the instrument dials indicated that all systems were functioning normally.

Once again Natalia heard the voice of Gagarin's widow:

"Yuri loved Star City. He thought it was a great joke when they named him mayor.

"Everything that was dear to him is dear to me. How could I leave Star City, the city that was a part of Yuri and has become his memorial.

"I especially cherish the unusual photographs I have of Yuri. For instance, I have some of him doing volunteer work on a Sunday—cleaning up the grounds. He organized others for volunteer work, and always did his share.

"Yuri was disappointed that the city had no monuments. He didn't know that Star City's first monument would be to him. Everyday I look at that bronze figure of Yuri. He stands with his back to me. In his hand he holds some flowers. He used to bring them to us, just like he brought happiness, joy and confidence. We miss him so much."

Natalia felt the touch of a warm hand. Someone was calling her, but she couldn't recognize the voice. It wasn't the voice of Valentina Ivanovna. Natalia opened her eyes and saw the woman passenger that had been sitting on the opposite seat leaning

over her in concern.

"We'll soon be in Monino," she said as she sat down again. "I didn't want you to miss your station."

"I'm getting off at Tsiolkovsky," Natalia said in as dignified a voice she could manage.

"You dropped your book," the woman said as she looked at Natalia with concerned eyes.

Natalia searched for the book she had laid on her lap, but it was nowhere to be found. Her guidebook, her dictionary of space terminology had disappeared.

"My editors assigned me to write a story about Yuri—about Gagarin." Natalia felt she could be open with her travelling companion. "So I was reading over my material all night long. But I seem to be so confused right now. I hope Valentina Ivanovna can help me."

Wheels grinding, the train came to a stop. The warm rain splattered against the glass. A tired voice announced "Platform Tsiolkovsky" and the train doors opened.

The Approaching Storm

Whether it is called a hurricane, typhoon or tornado, the tropical cyclone is a dangerous natural phenomenon bringing with it death and destruction.

Man has long dreamed of eliminating this danger, but so far he is unable to direct the movement of a cyclone let alone destroy it altogether. Yet even if he should one day have this power, and this is a reasonable assumption, it would not be feasible to use it. Tropical cyclones move excess energy from the tropics to higher latitudes and thus help maintain the planet's balance of energy and the existing climate of the earth's moderate latitudes. The artificial destruction of tropical cyclones could lead to undesirable, even tragic climatic changes.

But the situation is not hopeless. Experts estimate that it is possible to diminish by ten times the destruction wrought by a tropical cyclone if the storm's appearance and behaviour can be accurately predicted. But weather forecasting is extremely complex. Nowhere in the world is it accurate enough to meet man's needs. Meteorological forecasts for an extend-

ed period—more than ten days—are just sixty to seventy per cent accurate. Even the next day's forecast is reliable only approximately 85 per cent.

Meteorological forecasts are sometimes inaccurate because man does not yet fully understand all the factors that influence the atmosphere. And there are many such factors: the sun, amount of moisture in the earth's cloud cover (a veritable sea), the oceans, which cover three-fourths of the earth's surface, temperature variations in altitude, and many more.

Meteorological satellites have made a significant contribution to the solution of this problem by transmitting valuable information, especially over those areas lacking traditional observation posts: oceans, deserts, taiga forests, mountain ranges. Suffice it to say that during each ninety-minute orbit a satellite provides a view of atmospheric conditions from pole to pole over a stretch of the globe up to fifteen hundred kilometres wide. No other means of modern technology is capable of providing such a vast amount of observational data.

As they pass over data-receiving stations on earth, meteorological satellites transmit so much weather data so fast that only the most sophisticated computer is capable of processing it. Yet, though these satellites have opened a new age of meteorology (they can observe the entire territory of the earth in a very short period of time), they are still only machines. They scan the earth along their programmed paths and transmit each separate bit of information: the cloud cover, surface conditions of the ocean, borders of snow, etc. But they scan what they have been programmed to; any interesting phenomenon that falls outside their paths, no matter how close, will remain unobserved. But this phenomenon could be the cause of extremely important events.

Cosmonauts observe much more than satellites.

Most important, they are able to judge, analyze and compare what they have seen. Rather than merely transmit data, they describe the phenomenon, answer questions posed by specialists, repeat a scan to obtain more detailed information, alter a camera's aperture and exposure time.

Prolonged space flight allows cosmonauts to observe changes in weather conditions for sufficiently long periods. It is not unusual to hear a cosmonaut report from a space station: "It appears that a typhoon is forming in the Atlantic. Clouds are in a characteristic whirling formation and there's a spot in the centre that looks like the 'eye' of the storm. We'll determine the coordinates."

Here are just a few instances of how meteorological data from space have proved useful.

In 1973 the world press reported on the dangerous situation of the *Ob*, a Diesel-electric ship moored in ice. Special meteorological photographs from space helped the ship eventually sail into free water.

In spring 1977 information transmitted by *Meteor* weather satellites helped the m/s *Vladimir Mayakovsky* complete its difficult voyage across three oceans while tugging a large floating dock. One can easily imagine the dire consequences had the ship sailed into a hurricane.

According to information supplied by UNESCO, each year meteorological satellites help save four hundred ships.

Observations from space have been useful in discovering thawing glaciers and snow. The American *Nimbus-3* satellite, for instance, scanned the Alps and certain regions of Canada. A study of the pictures transmitted by the satellite revealed the beginning stages of a thaw in remote areas of the world. In mountainous regions, timely information concerning the beginning of a thaw is important for flood preven-

tion and the preparation of water reservoirs for periods of drought.

The economic benefit derived from our country's *Meteor* satellites, which were first put into operation in 1967, has been enormous. Information transmitted by these satellites and used to issue forecasts and timely warnings concerning floods, snow avalanches, hurricanes, and storms has contributed to an annual savings in material wealth of more than one billion roubles. On a global scale, the services of weather satellites save an estimated sixty billion dollars per year.

Our discussion here of the weather is not coincidental. There is reason to believe that in the future climatic conditions will play an even greater role in man's life.

Blizzards rage across the greater part of Europe and the United States in the worst winter of the century...

Earthquakes rock Japan and Arkansas ... volcanos rumble ... karst cavities swallow homes... The number of such cataclysms has sharply increased in recent years leading us to wonder if Mother Nature has gone mad and if extreme climatic and tectonic changes lie ahead.

Scientists have long known that the earth is in a constant state of change. Today, armed with the most advanced technological equipment, they are trying to answer these fundamental questions: when and where will changes occur and how will they affect man. Geologists believe that powerful earthquakes might bring death and destruction to huge regions sometime during this generation. And many inactive volcanos will one day erupt in full force. Scientists also believe that within one or two generations the earth will undergo serious climatic changes. Several theories exist as to when and how this will occur.

In the last 10,000 years civilization had developed in favourable climatic conditions. There have been periods of summer drought when not a drop of water fell, and winters, like that of 1981, that were unusually severe. But in general the weather has not hindered man. Today, however, specialists warn that this cannot go on forever. Gradually but inevitably the climate will change.

Climatologists are divided in their opinions concerning what it is that prompts climatic changes. Some believe the major cause is the change in the intensity of solar radiation reaching the earth. Others think the change in the earth's orbit might be responsible: at times the earth rotates further away from the sun and also gently rocks on its axis, thus influencing the amount of solar heat it receives. Some cycles of climatic changes last millennia, others—much shorter periods.

Studies of changes in the earth's orbit show that they coincide with ice ages. This strengthens the hypothesis that the earth's movement in space could have a significant effect on weather.

Weather satellites have already been very beneficial and in the future will provide scientists (and not just climatologists) with even more information. We can only hope that information revealing the negative effects of man's activity will allow us to take appropriate measures, and that we will no longer need to speak about the acidification of rivers that has resulted in the disappearance of valuable species of fish or the extermination of insects and birds due to acid rains. Scientists have determined that more than two-thirds of the acid precipitation in Sweden and Norway is due to sulphur and nitrogen emissions from Western European countries located hundreds of kilometres away from the Scandinavian peninsula.

Finally, we should mention the problem with the ozone layer which protects life on earth from deadly ultraviolet solar radiation. It is now generally acknowledged that an entire range of synthetic products may decrease the concentration of ozone in the stratosphere to a low enough level to cause biological damage. Such products include freon, which is widely used in agriculture, manufacturing and households, nitrous oxides, emitted by airplane engines in the upper troposphere and indirectly into the stratosphere, and a number of other substances.

Perhaps man will be able to prevent these dire predictions from coming true. But one thing is certain, action must be taken now to ensure his future.

Ensuring Future Supplies

Natural disasters seem to be occurring more and more frequently. The severe drought that plagued the Sahel region (Africa) from 1968 to 1973 destroyed both crops and livestock. In one Nigerian region alone, where the drought of 1972-1973 was the worst in the country's history, approximately four hundred head of cattle were lost and crop destruction was estimated at more than one million tonnes, i.e., fifty per cent of average annual production.

The world economy was seriously affected by the 1972 and 1975 droughts in the Soviet Union and the 1976 drought in Europe. World grain reserves were reduced by tens of millions of tonnes, and prices doubled. In 1972 crop loss in the USSR due to drought amounted to 19 per cent of expected yields, in 1975–30 per cent. The 1972 drought was the longest in the country's history, the 1975–affected the largest territory.

Frequent droughts pose two problems: first, in-

sufficient food, and second, insufficient fresh water. To a certain extent, available fresh water determines the level of development of a country's economy. The reason is simple. Those countries which have insufficient fresh water reserves (and their number is increasing) must construct facilities to produce water. For example, one industry (metallurgy, for instance) cannot operate without another industry (a water desalination plant). Obviously, this is both expensive and not very effective.

Is it possible to obtain the needed amount of fresh water some other way? We can answer this question only by utilizing qualitatively new methods of surveying the planet's water resources. Some scientists believe that observations from space are the best way to do this. Equipment aboard space laboratories can determine the size of a snow cover (or glacier) before a thaw and then estimate the flow of water through vast territories. Moreover, instruments can detect in what region underground water will surface. Though this information may not be able to ensure a steady supply of water, it certainly serves to help increase that supply.

Let us now turn to the world food problem.

It is estimated that by the year 2000 the global population will reach 6.18 billion people. The question arises: will the world be capable of feeding so many people? Inasmuch as most arable land is already under cultivation, virtually all the increase in food production must be derived from intensification of agriculture: more fertilization, irrigation, improved crop strains and breeds of animals. In other words, the production of food will to a significant degree depend on energy production, and the real cost of food could double by the end of the century.

The rapid disappearance of forests has become a serious ecological and agricultural problem. The

peoples of many countries use wood for heating and cooking, and in certain regions, the entire day is spent collecting firewood. Timber cutting destroys plant and animal life. Most of this destruction occurs in tropical regions, with the greatest damage taking place in arid and borderland areas on which local varieties of important grain crops have acquired such qualities as for high yield and disease resistance. Replacing wild strains with high-yield, commercial seeds will make it more difficult to grow disease-resistant strains in the future.

It is clear that we must begin to look for new food sources. Many scientists believe, with good reason, that the ocean offers the best prospects in this area. The total biomass of the world's oceans has been estimated to be tens of billions of tonnes. It is calculated that the Atlantic Ocean alone can provide the nutritional equivalent of twenty thousand annual land harvests.

It will, however, require an entire army of specially equipped vessels to harvest the ocean. And when we take into consideration that more than half the time spent in the ocean will be devoted to searching for harvestable seabeds, the important role of weather satellites becomes clear: their use will save billions of roubles.

Observations conducted by cosmonaut crews aboard the *Salyut* space stations have demonstrated that space technology can provide information about global oceanographic, hydrobiological and bioindustrial conditions.

The Galactic Spiral

April 12, 1961. It was a date that would change his life. But he would not know it until later. Pyotr

Klimuk was studying at a military flying school. He heard the news about Gagarin's flight while in a radio class. Man had conquered space; it was the beginning of a new era where the secrets of the universe would be explored and amazing discoveries revealed. But at that time, Klimuk had no idea that he would play a direct role in this great venture.

After graduation Klimuk was assigned to an air force unit. He flew more and more frequently, improving his skills in different types of aircraft.

Klimuk went before his first medical commission (there would be many more) in Leningrad. He was certain his close friend would pass, but he wasn't so sure about himself. Yet the opposite happened: his friend was sent back to his unit, while he was given the go-ahead.

After Gagarin's flight, there were many other launches, each representing a new step forward along the difficult, unknown path of space exploration. New heroes were being made...

Pyotr Klimuk was training for a launch as well. He was already familiar with flying planes, but he didn't much care for parachuting. Many others shared his feelings, yet they continued to jump—over ground and over water, day and night.

As part of the training programme, Klimuk began to study reports, attend classes and participate in simulation exercises years before his scheduled launch. The programme took all his time—from early morning till late at night. There was little left of his personal life. Yet perhaps this difficult but at the same time enjoyable work had become his personal life.

When Pyotr Klimuk was asked: "What's the most difficult aspect of your work?" he answered: "The training," and then added: "I've known some talented men who have almost completed the training programme and right at the end called it quits be-

cause of some insignificant factor. Then it's goodbye to space, Star City and all those years of hard training."

Klimuk went through all the stages of training. Like the others, he found the going tough. More than once he was a member of the back-up crew: after watching the first crew go up in orbit, he started the training process all over again. Of course, on such days he had second thoughts. Once, while completing a routine training exercise, he complained about his luck. He had been with the programme for more than seven years, and it appeared he would never go up. A young training assistant cheered him on: "You'll go up."

"If I ever go up in space, I'll buy you two cases of candy," Klimuk told the young woman.

And there came a time when Pyotr Klimuk was up in orbit. During a routine communications hookup, mission control asked if the crew had found the envelop marked: "To be opened in orbit". Inside was Klimuk's written promise to buy two cases of candy.

The training programme was diverse, even including classes at the planetarium. Konstantin Portsevsky, Director of the Moscow Planetarium, talked about how he met the first group of cosmonauts. One day he was told that another group would be joining the class of pilots already studying at the planetarium. The planetarium director didn't consider this at all unusual, but he was surprised to learn that the new group was required to have several times the usual number of lessons.

Portsevsky himself and B. A. Maksimachev, a scientific researcher at the Moscow Planetarium began to teach the new group, and they easily established a friendly relationship with the young men. Teachers are always happy to have bright students, and these pilots proved to be very capable.

The students continued to discuss what they had been taught after the lesson was over. One day, when the talk became especially heated, Portsevsky turned to the nice-looking senior lieutenant who had so ardently expressed his belief in interplanetary travel and said: "You speak as if you're ready to fly to the stars straight away." It was January 1961.

That spring, on April 1, the joke going around Star City was that a man was in space. But twelve days later, it was no longer a joke. The planetarium director looked at the cosmonaut's picture in the newspaper and recognized the senior lieutenant with whom he had argued.

Soon afterwards Yuri Gagarin visited the Moscow Planetarium and met with his former teacher. "The remarkable thing about it is," he said, "that the stars in the planetarium look so real that up in orbit you start to think you're not in a spaceship but back in the planetarium."

The classes Pyotr Klimuk attended at the planetarium proved to be useful as well. One of his assignments while orbiting with Valentin Lebedev in *Soyuz-13* was to study the ultraviolet emissions of distant stars and constellations through the *Orion-2*—a special telescope designed by Armenian scientists. The instrument withstood the jolt and g-pull of the *Soyuz* spacecraft as it shot into orbit and later gave the cosmonauts a clear "picture" of the distant stars' ultraviolet radiation.

Klimuk and Lebedev travelled to Armenia frequently to learn the skills required for operating the telescope. They studied and read as much for their own interest and enjoyment as for learning practical skills. But what they saw through a telescope could not compare with their view of the vast and limitless cosmos from the window of their spacecraft.

The *Soyuz-13* mission lasted eight days, and the

cosmonauts obtained many spectrograms. By studying them, scientists were able to discover new phenomena that increased man's knowledge about space and his world.

Pyotr Klimuk continued his "stellar" studies during his second space flight as well, this time with fellow cosmonaut Vitaly Sevastyanov. The two men operated a solar telescope which allowed them to view spectrograms of sunspots—flocculi and protuberances—impossible to obtain on earth even on the clearest day due to atmospheric haze.

So it turned out that Klimuk was able to put his stellar studies to good use: on his two missions in space he was called upon to work with astrophysicists.

In 1971 it was discovered that certain celestial objects known as Markaryan galaxies emitted unusual radiowaves. Many of the processes occurring in these galaxies are inexplicable. For example, some galaxies emit strong radiowaves from their "arms" as well as their nuclei.

It should be noted here that Soviet scientist Viktor Ambartsumyan has long argued that, classical theory to the contrary, galaxies are born as a result of emissions from super dense substances, not the condensation of gases. According to this hypothesis, the nuclei of certain galaxies emit a substance which eventually leads to the formation of their "sisters" or satellites. The predominance of emissions close to the ultraviolet range is one of the confirmations of this type of activity. From studying these spectra, a colleague of Ambartsumyan, B. Markaryan, an astrophysicist with the Byurakan Astrophysical Observatory, determined that a predominance of ultraviolet emissions was characteristic of approximately one thousand galaxies, the majority of which are spherical in shape.

Markaryan's work quickly attracted the attention of other scientists. Of special interest were three newly discovered galaxies—all bright and encompassing an area of approximately eighty thousand cubic light years. Surprisingly, they had an irregular form. Pictures of the galaxies showed small, very bright formations that looked like clusters inside them. Scientists began to study these galaxies in earnest, and many were aided by the galactic atlas compiled by Soviet astrophysicist B. Vorontsov-Velyaminov. Some of the most powerful observatories in the world joined in the study of galactic optical spectra. It was discovered that certain galaxies contained lines in their spectra characteristic of pockets of interstellar gases, particularly hydrogen.

The first conclusion made by the scientists studying Markaryan galaxies was that the clusters were tremendous areas of ionized hydrogen, nidi for the formation of stars on an unprecedented scale. Readings showed that they had been in existence for only tens of millions of years—an insignificant period in astronomical terms.

How did they form? Why did several clusters arise in one galaxy? Did they result from a cataclysmic inner process or were they produced due to an inward flow caused by the gravitational pull of neighbouring galaxies? Or could they be explained by the collision of two galaxies? Perhaps the result of capturing intergalactic gas? Or could it be that the clusters were "cosmic fossils"—the last trace of the phenomenon which many galaxies shared at the early stages of the formation of our universe? All these hypotheses had to be tested.

If the galaxies with clusters were huge stellar nidi they should contain stars of tremendous mass—ten times or more greater than that of our sun. The fate of such a star is known: a powerful explosion causes

the star to erupt in a supernova with its "ashes" becoming a neutron star. The first wave of such a cosmic explosion heats the interstellar gas to a temperature where it begins to emit X-rays. Thus, the discovery of X-rays in galaxies with clusters could supply certain information concerning how fast extremely massive stars are formed.

Scientists have observed not only increased density of matter in the universe but also tenuity of matter: strange empty pockets in space. Scientists at Kitt Peak Observatory, in Arizona measured red shifts in the emissions of galaxies in six regions (three in the northern celestial hemisphere and three in the southern). To their great surprise, they discovered that in each of the three regions in the northern hemisphere there were galaxies from three to six hundred million light years from the earth and almost empty space between them.

Most surprising, these regions are shifted at 35° from each other; they are as wide as they are deep and are approximately 3×10^{25} cubic light years in volume. The density of matter in these empty pockets is at least ten times less than usual.

Although these empty pockets represent several per cent of the overall volume of the observed universe, they are not significant enough in size to violate the cosmic principle of the uniformity of the basic properties of space in all directions.

At some time in the future an interstellar spaceship will carry a group of pioneers and settlers from earth deep into the universe. In the following centuries, their descendants will spread out into the galaxy, inhabiting the planets they have discovered orbiting around stars barely visible from earth. When the time comes for historians to write about this extraordinary colonization, they will trace the beginning to our century—the Golden Age of astronomy.

Scientific perspicacity and technological genius have joined forces to give rise to this Golden Age. Radiotelescopes which can pick up cosmic emissions invisible to the human eye have led to the discovery of black holes, pulsars and huge clouds which may represent the nidi of star formation. Man has also uncovered relic radiation—the echo of the "big-bang", which, according to many scientists, marked the origin of our universe.

Advances in the field of electronics have improved the resolution of optical telescopes, allowing astronomers to study galaxies millions of light years away from the earth. Until recently, they were simply unseen. Space probes with sophisticated sensors have made it possible to study the spectra of electromagnetic radiation invisible from the earth—ultraviolet, gamma and X-rays. It was in this manner the discovery was made that the universe is permeated with radiation. Instrumented capsules have also studied the surface of Mercury, Venus, Mars, Jupiter and Saturn, transmitting close-up pictures and even images from the surfaces of the planets. We now have a new understanding of the planets in our solar system.

These discoveries have radically altered traditional views about the universe. No one now thinks of the heavens as majestically serene and quiescent. The cosmos is constantly changing: stars explode and cataclysms reverberate through galaxies, black holes appear with a gravitational pull so strong they emit no light rays, oceans of hot gas cool and contract, giving birth to new stars ...

Pyotr Klimuk and Vitaly Sevastyanov were intrigued with their studies of the solar system and outer space. In the middle of their flight, mission control decided to allow the cosmonauts to conduct a few experiments of their own choice each day.

This greater flexibility encouraged a more creative approach to the research and led to fruitful results.

At one time a novice himself, Pyotr Klimuk became one of the more experienced cosmonauts and eventually began to help train others for space missions.

Two Suns

We have discussed distant suns and worlds. But the road to another world starts at one's own threshold. And our home—the solar system—is of no less interest than distant galaxies.

Before the Soviet lunar probes and American astronauts brought back samples of lunar rock, man knew nothing for certain about the history of the moon. Extremely sophisticated laboratory experiments conducted on the rock revealed with an accuracy of roughly 100 million years that the moon and earth are both almost 4.6 billion years old. In other words, the moon, earth and small celestial bodies in the solar system all formed at the same time. Moreover, samples of lunar rock will help scientists learn what took place in the interval between the beginning of the formation of our planet to the solidification of the oldest earth rocks, i.e., 3.5 billion years ago.

Compared with Earth, Venus has always had little water. On our planet, fossilized traces of carbon are found in sedimentary rock (primarily limestone). Interestingly, the amount of carbon roughly compares to the amount of carbon in Venus's atmospheric carbon dioxide. Despite the great similarities between Venus and Earth, their atmospheres are quite different. We can only be thankful that water created favourable conditions for the development of life on our planet. Of course, it would have been a

much more interesting state of affairs if Venus also had water: perhaps man would have been able to observe an extraterrestrial civilization on a neighbouring planet. But we must continue our search for intelligent life on distant stars in galaxies millions of times further away.

At one time man had considerable hope that there was life on Mars. But the robot *Viking* spacecraft that touched down on Martian soil dashed that hope after conducting biochemical tests on the planet's surface material. The presence in the Martian soil or atmosphere of any type of living organism with biological processes even remotely similar to those on Earth would have been considered a positive result. As a matter of fact, *Viking* instruments did register signs of activity. But it was later discovered that the activity was due to the chemical properties of the oxygen-poor Martian sand exposed to intense cosmic radiation. The most conclusive negative results were obtained from molecular analyses, which revealed the total absence of hydrocarbons in those areas where the *Viking* ships had landed.

The cosmos contains many riddles and mysteries. And though science fiction fans retain little hope of man discovering life within the solar system, the fantastic findings of scientific research have given us new ideas about the nature of outer space in the vicinity of our planet. We have taken a giant step forward in gaining an understanding of our solar system and the reasons why our world brought forth life.

Calling All Intelligent Beings

Since we have been unable to find life within our own solar system, logic dictates that we must expand our area of search and improve our methods.

The first congresses convened to discuss the possibilities of extraterrestrial intelligent life were optimistic about success. The reaction of the scientist who discovered pulsars was indicative of the times: he concluded that some form of intelligent life was putting out the extremely regular emissions, and decided not to disturb people with the knowledge that extraterrestrial beings had found our planet. Today we know that pulsars emit regular radiowaves due to natural causes.

The question arises: having found no sign of life in our own vast universe, why should we hope for success in more distant space? Could life on Earth be unique?

The first to express this view was I. Shklovsky, Corresponding Member of the USSR Academy of Sciences. For years Shklovsky searched for intelligent life on other planets, so he can by no means be accused of harbouring preconceived notions. Concerning his belief that life was a rare phenomenon, the scientist had this to say:

"I believe the life of man is finite; this is why so many call me a pessimist. Does this mean that the day will come when man will no longer exist? Yes, he will no longer exist, just as if he never had existed. I cannot predict, nor can anyone, what concrete form the final stage of rational life will be. There was a time when not only was there no life on the earth, there was no earth, no sun, no stars.

"Every form of material is a category of history, existing within a specific period of time. This is a general rule and man is no exception.

"I believe that in failing to uncover any sign of life on Mars, the final experiments of the American *Viking* mission in effect proved that even the simplest life forms do not exist in our solar system. It is not very likely that the other planets can sup-

port life. True, some scientists suggest that life may exist on some of the satellites of the larger planets, but I don't think there are any grounds for this hypothesis. An insignificant number of stars have planetary systems and probably only a few of these show signs of life. As far as intelligent life is concerned, I believe we are a biological phenomenon. Yet perhaps somewhere there are other civilizations. In any case, after ten years of passionate involvement in research on the problem, my interest has cooled considerably."

Another Soviet scientist, P. Makovetsky, recently proposed directing the search for life primarily at the source of powerful radio emissions—pulsars—in the Crab Nebula, thus increasing the chances of success. His suggestion is a good one in that it considerably narrows the field of search. But we shouldn't rule out the rest of the galaxy.

As for the failure to find any extraterrestrial civilization, Soviet scientist V. Troitsky has come up with a convincing explanation: even the most highly developed civilization has access to only as much energy as its star possesses (our star is the sun). The powerful transmitter needed to emit cosmic signals would have to be located far from the given planet to protect its inhabitants from radiation exposure and prevent burning up the atmosphere. Since the cost for such a transport would be enormous, a civilization would have to construct a transmitter many times less powerful than its star. But that means the signal it sends would be very weak. And if the means for searching for this signal are as unsophisticated and inefficient as those man possesses at the moment, there is little chance of success. A comparison could be made to building a huge bonfire in Prague and hoping that someone in Moscow or London will see it. Of course, it seems to those

who built the fire that it is visible from everywhere.

Other scientists disagree with Troitsky and believe that radiowaves can reach distant stars and even carry with them coded information.

The question is, how can this information be transmitted? Many scientists believe the most suitable wavelength is 21 centimetres. Such emissions can travel through interstellar space with virtually no impediment and should be, according to V. Troitsky, "known to all civilizations."

The task is by no means trivial, and scientists from a number of countries have worked together to try to solve it. For example, the USSR Academy of Sciences' scientific council on radioastronomy formed a section on "Searching for cosmic signals of artificial origin". Scientists working in this area have established that there is little chance of finding intelligent life closer than hundreds of parsecs away from the earth. And the greater the distance, the more complex the task for radio astronomers.

In 1974 American scientists working with the three hundred metre radio telescope in Arecibo, Puerto Rico, beamed a "cosmic letter" in the direction of Messier-13 Nebula. The signal included coded information about our solar system, man and important chemical elements, and will cross the path of hundreds of thousands of stars. It is conceivable that one will be inhabited by intelligent beings capable of receiving and decoding the information. And then we will perhaps be sent an answer. Of course, it will take 24 thousand years for the signal to reach the edge of our galaxy, so we cannot expect an answer for another 48 thousand years, i.e., sometime in the 500th century. Earthlings will have to develop some patience.

In August-September 1977 the US launched two *Voyager* spacecraft to study Saturn, Jupiter and Ura-

nus. After fulfilling their missions the spacecraft will leave the solar system and begin their endless voyage through the universe. Attached to the ships are two identical capsules containing a gramophone record on a guilded disk pressed from a special alloy and a diamond needle. The quality of sound should be preserved for billions of years. On the record are greetings from people in sixty languages plus a variety of sounds: the voices of whales, cry of a newborn, howl of the wind, noise of a train, screech of automobile brakes, splash of water and, of course, music: Bach, Beethoven, rock-and-roll, blues, folk songs.

The capsules also contain more than one hundred different images: human anatomy, the molecular structure of DNA, shapes of our oceans and continents, flowers, birds, animals, snowflakes and a man depicting the position of the earth in the Milky Way. If one of the *Voyagers* is discovered, extraterrestrial beings will be able to gain some understanding of our civilization.

As we can see, scientists are divided in their views concerning the question of intelligent life on other planets. Some believe that life such as ours can develop only given a rare combination of extraordinary circumstances, and that intelligent life is not the rule but the exception: the chances of finding it elsewhere are negligible, if they exist at all. Others declare that out of fifty billion planets similar to our own, at least two to three billion in our galaxy support life and several million—intelligent life.

This last claim has been undermined by recent studies which reveal that all the stars similar to our sun are binary. Thus the surface temperature of any planets which might be revolving around them would fluctuate between extremes too great to support life.

Therefore, in all probability life is exceptionally

rare. But how can we speak with any authority about life on other planets when scientists cannot agree as to how it arose on our own? The suggestion that living cells arose from non-living matter does seem far-fetched. But there are scientists who adhere to a hypothesis about the cosmic origin of life. They believe that spores could have become attached to meteorites and thus transported to earth.

An even more fantastic proposal suggests that a highly developed civilization transported microorganisms to earth for the purpose of propagating life. Supposedly our "ancestors" should be returning shortly to pay us a visit and check on the success of their experiment.

Two leading Soviet scientists specializing in the search for extraterrestrial civilizations, Corresponding Members of the USSR Academy of Sciences N. Kardashev and V. Troitsky, have said that the majority of historians do not consider this hypothesis seriously; however, there is no scientific basis for excluding the possibility that earth might have been visited by other beings sometime in the past. Research in this area offers much of interest.

Many scientists have dedicated their lives to searching for answers to the secrets of the universe, the formation of worlds and the possibility of civilizations on other planets. Konstantin Tsiolkovsky was one of the most distinguished of these scientists. In his works he tried to envision space exploration in the near and distant future. Predicting that man would travel into space in rockets, he showed the necessity for this exploration. Tsiolkovsky described the earth as the cradle of intelligence, but said that we could not live in a cradle forever.

The earth, Tsiolkovsky said, is only one of the planets where life is possible. Space travel will provide the material basis for the future of mankind. People

are weak today, but in a million years their power will be such that they will be capable of altering not only the earth's surface but its oceans, atmosphere, vegetation and themselves. People will learn to control the climate; they will rule beyond the solar system just as they do on earth. In their search for light and space, they will travel beyond the solar system, reaching other suns and utilizing their fresh supplies of energy to replace their own dying star. People will also build structures on other planets and asteroids. In the event that the earth begins to cool, the people of the future will save their world by towing it to another orbit nearer the sun or, with the help of jet rockets, transport it to another galaxy.

Tsiolkovsky believed that man's reward for space exploration would be the eternal life of humanity. He was a great humanist and optimistic about the future. There was, in his mind, only one condition to be met for man to fulfil his great destiny: the cosmos must be a realm for peaceful cooperation. Failure to meet this condition would bring general destruction.

Space exploration in recent years has shown that many of the predictions made by the great scientist have already been realized or have at least become real prospects.

Tsiolkovsky had many interesting views. Speaking about rockets, he once said: "Many believe my concern and interest in rockets is for the sake of rockets themselves. But they are greatly mistaken. I consider the rocket only the means, the method by which we may penetrate into the depths of space. It is by no means an end in itself... Unquestionably, we must have rocket ships, for they will enable man to settle other worlds. And my concern and interest is in that settlement. If another means of movement in the cosmos should be discovered, I will accept it... What

is important is to resettle people in space. We must adopt a 'cosmic philosophy'."

With profound philosophical cogency Tsiolkovsky proved that large-scale space exploration was useful both for scientific and practical purposes. Nor did he divorce our planet from the processes at work in the universe. He thought of the earth as an element or particle in one enormous process of development, and suggested that intelligent beings might be controlling the development and structure of the universe. Tsiolkovsky believed the universe was inhabited and that man would soon meet other intelligent life forms.

Ignition Sequence Start

The Soviet Union has achieved great success in its space programme. This is a fact which makes the history of Soviet rocketry of considerable interest.

One of the authors of this text met the Chief Designer back during the period of the *Vostok* construction. The designer of the spacecraft explained the construction himself and spoke about the ships cosmonauts would fly in the future. After Gagarin's flight, when other launches were being readied, he suddenly appeared in Star City. Everyone thought he was on vacation in the Crimea, and now here he was walking down the street. Ten minutes later everyone had been called to a meeting. Someone asked what had happened to his vacation plans. He scowled and replied with a question of his own:

"How's the training programme?"

The complaints spilled out: there's not enough of this; we're completely out of that. Most of the problems had to do with the lack of training apparatus. Special equipment was hard to get, and simulators were in short supply.

"We'll think of something," the Chief said and then left.

A week later two trucks with the long-awaited supplies rolled into the city.

People who met Korolev formed different, often contradictory, views of his character. Some praised his unpretentiousness and candour, others thought him too gruff, and still others, who saw him only at work, voiced their doubt that he had any kind of a personal life. To many it seemed that he never left his job. There are no contradictions here. This was a colourful, strong personality. True, Korolev was touchingly sincere, unpretentious and accessible. But he could also be mercilessly strict and demanding whenever he came into contact with slackers and loafers. He exacted precision and order at all times and in all things, and was intolerant of vanity.

When the first cosmonaut recruits met the Chief, he told them with characteristic frankness:

"If you're here to achieve heroic feats, we aren't going to get along. We have work to do. It is difficult but extremely interesting. This is what we must prepare for."

Later it became known that Korolev kept an ottoman in a small room off his office. This was where he slept during the long and difficult days before launches. His heart was already giving him problems, and his nerves were stretched to snapping. But whenever he was needed, he could be found on the job.

We provide here a few of the documents from Sergei Pavlovich Korolev's personal records.

His personal history, written in 1952:

"I was born on December 30, 1906 in the city of Zhitomir. Both my parents were teachers. My father died when I was three. I was raised by my mother until I was ten, and then by my step-father, an engi-

neer-mechanic. At present my step-father, Grigory Mikhailovich Balanin, is an assistant professor at the Moscow Institute of Transportation Engineers and my mother is retired. I have no brothers or sisters.

"I completed secondary school, the final two forms at the construction vocational school in Odessa where I acquired the trade of roof-tiler. I studied another two and a half years at the aeromechanical section of the Kiev Polytechnical Institute. In 1927, when the KPI closed this section, I transferred to the aeromechanical department of the Bauman Technical Institute in Moscow. I graduated in 1929 after defending my graduation thesis—the design of a two-seater plane that had already been constructed and was operational by that time. In 1930 I graduated from the Moscow School of Pilots while continuing my work.

"During the entire period of my studies I lived on my job earnings. From 1924 to 1927 I worked at various jobs (newspaper deliverer, carpenter, etc.)

"In 1927 I began to work at a plant in the All-Union Aviation Amalgamation...

"My designs for light aircraft and gliders were accepted for production, and several of my articles on aviation technology were published.

"In 1929 I began to study rocket technology. Continuing my work at the All-Union Amalgamation, I also headed one of the first groups on rocket technology (formerly GIRD—Jet Propulsion Study Group). In 1933 I went to work in this field full-time and continue my work in this field at present.

"By 1951 I had completed 40 scientific works and project designs (see list)...

"Since 1947 I have headed the Special Design Bureau."

In 1946 Korolev was appointed Chief Designer

for the construction of long-range guided ballistic missiles. At the same time, chief engineers were named to head such divisions as jet engines, guidance systems and logistics supplies.

The Soviet Union's rocket building industry was launched under extremely difficult conditions. The country had not yet recovered from the aftermath of the Great Patriotic War (1941-1945): both industry and agriculture needed to be rebuilt. Meanwhile, the ominous threat of another war was in the air.

In the autumn of 1948 the first Soviet long-range missile, the R-1, was ready for testing. On October 10, it was successfully launched, flying a distance of 288 kilometres and hitting the target. The construction and testing continued.

In August 1957 an intercontinental ballistic missile was launched successfully, a tribute to Korolev's engineering genius. It was the start of a revolution from single- to multi-stage rockets. The Chief Designer's daring decision to build a huge rocket eliminated many problems. The incredible reliability of all the rocket stages elicits admiration even today.

Throughout this entire period Sergei Pavlovich remained didicated to achieving his dream—space exploration. The first rockets built by his design bureau had already been flown to heights of one hundred, two hundred and more kilometres with scientific instruments and animals on board. These were known as "academic" rockets.

On October 4, 1957 the world's first artificial satellite was launched, heralding the start of the space age. Less than two years later, lunar probes were sent into space.

In his film "The Taming of Fire", director Leonid Khrabrovitsky shows the Chief Designer of long-range ballistic missiles at the most difficult point

in his life—the establishment of the Soviet missile and then space rocketry industry. The film protagonist, designer Bashkirtsev, is a composite characterization, and his biography includes many aspects from the life of yet another leading designer of Soviet space rocket technology—Hero of Socialist Labour, Lenin and State Prize Winner, D. Sc. (Technology) Aleksei Mikhailovich Isayev.

In order to give the reader a clearer understanding of the type of person Isayev was, we reproduce here some of the letters, documents and reminiscences of the people who knew him well.

Aleksei Isayev's brother, B. M. Isayev USSR State Prizes Winner, D. Sc. (Technology), wrote:

"Aleksei inherited many of his character traits from our father. He was compliant in his personal relations but just as firm in achieving his goals. He was impressed that our father volunteered for the front in 1915, even though as an assistant-professor of the law faculty at Petersburg University he was exempted from service. He fought as the commander of a cavalry machine-gun unit in the Caucasus. The Revolution did not cause him to waiver—in 1918 he became a member and professor of a socialist academy.

"We lived in a small apartment in Moscow. There was one desk for all of us. Our father, Aleksei and I took turns using it. At one time we were taught mathematics in school by Andrei Kolmogorov (who later became an academician) and physics by A. V. Faleyev (the author of school textbooks).

"Each summer we would travel with our father through the Crimea, Caucasus and Central Russia. Years later, while he was studying at the Mining Academy, Aleksei travelled independently, either by himself or in the company of his close friend Yuri

Beklemishev (Krymov). He was true to that friendship for many years. On September 20, 1941, Yuri Krymov, by that time a well-known writer, was killed at the front.

"After graduating from a ten-year school, Aleksei enrolled in the electromechanical department of the Moscow Mining Academy. In June 1930, two months before he was to complete his studies, he was expelled. A number of widely different educational reforms were under way at that time, many of which were by no means well-founded or really necessary. Aleksei had protested against one of these. After his expulsion, he went to work on the construction of the Magnitogorsk Iron Works."

Taken from a letter written by A. M. Isayev to Yuri Beklemishev (Krymov) on November 24, 1930.

"I am now back at the design bureau. Remember how I beat my chest with my fist and swore not to design anything? But I had to. I chose the lesser of two evils, which turned out to be the evil of designing. And now, perhaps, and not even perhaps—I'm happy with my work. Our design bureau consists of our chief, me, a technical designer, and two draftsmen-designers, not counting two silly young girls and a slow, old copyist. I was able to demonstrate that despite my inexperience, I knew more about the work than all of them. So, undoubtedly, I will get the most complicated work...

"The biggest problem now is living quarters. I'm still living in a communal barracks where it is impossible to do anything but tell anecdotes. And I desperately want to take up the study of something like electrotechnology or English. The problem will soon be solved. I am fed up and angry. Tomorrow I'm going to see the deputy head of construction and I won't leave without the key to a hotel room.

"Well, time to close. Please give this letter to papa. He will find it interesting."

B. M. Isayev:

"Aleksei worked on the Magnitogorsk project until October 1931. Then he quit his job, returned to Moscow and re-enrolled in the Academy. In January 1932 he graduated and, in accordance with his request, was assigned a job at the Magnitogorsk Iron Works. From there the road would lead him to the construction of the Zaporozhye Steel Amalgamation."

From a letter written by A. M. Isayev on April 7, 1932.

"I breathe in life, the smell of my 23 years, my remarkable 23 years. How wonderful is the earth, how bright the sun that bathes it, and the air—thick, sonorous, carrying the marvelous sounds emitted by steam engines, cranes and excavators!

"Though everyone is still wearing a coat, I'm walking without a hat and in my shirtsleeves, but I still feel I have too much on. I want to take off my shirt and embrace the dry earth, to feel a boiler plate against my naked body, to breathe, breathe and sing.

"So what if there's no buffet or canteen at the plant, as long as you can take your 400 grammes of brown bread out of your pocket at noon and wash it down with water.

"What's wrong with waking up at half past five from the loud noise of the construction—the dozens of steam engines, cranes and excavators shoving their sounds through your open window?

"What's wrong with pouring out a glass of cold Dnieper water and drinking it (that way you don't feel hungry) and latching on to the buffer of a work

train that takes you along with a crowd of other people right from a fantastic new city to work drawings and work dilemmas, to casings, iron and concrete?

"What's wrong with suddenly getting a wonderful idea for raising an inclined bridge up to a blast furnace, running across the steppe to it, and knowing that there, where larks are singing today, in six months' time steel will be pouring out? And will my foot slip as I stand at the very top of the blast furnace under construction and mentally draw the outlines of the bridge that will be built here?

"After all, there's tomorrow, and the day after tomorrow and many more days. Do you think I'll build one Dnieper plant during this time? You are mistaken. I'll be everywhere, in many places, because I am 23, only 23!

"Isn't this the truth, fellows?

A. Isayev"

From a letter written by A. M. Isayev on March 17, 1934 from Nizhni Tagil.

"Greetings my lovely family!

"I relax on my days off, but the other five days are spent in intensive work. The days aren't very productive. There's a lot of talk and different people come by who need explanations, advice and instructions. Visits to the director, lunch—all this takes up precious time. The fact is, we don't know how to organize ourselves, our time and our work, how to speak briefly and to the point. But when everyone goes home at 6 o'clock, I remain alone in the large building. With amazing speed, my designs are sketched on paper. I sit until 11 or 12, sometimes until one o'clock in the morning, and when I leave, the watchmen stick their heads out into the long corridor, wondering what I am doing there at such a late hour.

"The biggest project I decided to work on here is a district cement factory. I'm making sketches and a technical drawing. The factory is a good one. I like it very much. I put a lot of thought into it and outdid the Americans. When it's built, I will be able to take pride in it as the best thing I ever did...

"I have a house now. There are people living here with whom I spend the few hours that remain from my flights of fantasy in the construction sphere. They feed me when I'm hungry and bring, whenever they can get them, sweets. Frequently, we are filled with youthful exuberance—we launch into horseplay in the streets, wallow in the snow, climb over the construction site, and go sledding.

"The evenings are sometimes melancholy. Yesterday after a hard day at work, we fried potatoes and drank tea, and then sat around hardly speaking. Each was thinking what a great group of chaps we were and how good it was to be together, that we would soon be taking off in different directions and would perhaps meet sometime in the distant future on another construction site. And that we would never in our lives live this time again.

Aleksei"

From A. M. Isayev's personal records.

"Dear Comrade Director,

"Circumstances compel me to turn to you directly with the request to allow me to work in aircraft construction.

"I have been interested in aviation for a long time and can say that I am not entirely ignorant of the subject. Work at the design bureau is my only way to prove to you that I have designer ability. At any rate, you will be risking less than what you have to gain, for, as you know, it is those with the ardent desire who move any project ahead.

"One year will be sufficient for me to become an aviation engineer and take a 'legitimate' place in the aviation industry.

"I am not asking for a large salary or even an apartment. I am completely free now and can start work immediately.

"If my request has proved convincing, have the secretary inform me at my home address.

Isayev"

Lenin Prize Winner, Cand. Sc. (Technology) A. A. Tolstov:

"Isayev came to work at the Viktor Bolkhovitinov design bureau in 1934. During those first years our teams worked side by side and our desks were next to each other. I observed how Isayev mastered the aviation technology that was new to him. He worked quickly, easily and confidently. It was clear that he had a large and solid general technical background and remarkable engineering talent.

"In the early thirties work was begun in the country on the construction of new types of engines for airplanes and rockets. Isayev became interested in this promising field.

"In 1940 the Bolkhovitinov design bureau underwent a real 'identity crisis'. It was evident that not one of the projects already begun could be completed, and the Bureau's management could not find new work. One of the engineers at the bureau, A. Bereznyak (a graduate of the Moscow Aviation Institute) developed an idea for creating a fighter-plane ('interceptor') with a liquid-fuel rocket engine. According to Bereznyak's calculations, such a plane would have considerably greater lift velocity and speed than the planes with internal combustion engines being constructed at that time. The faster, more powerful jet engine planes would be more

effective in countering enemy bombers.

"Bereznyak shared his idea with Isayev (whom he evidently chose as the most likely to support his project). And, indeed, Isayev liked the idea and began to help Bereznyak with the design. Bolkhovitinov soon noticed that his two employees were working 'on the side'. He declined to accept the project, but allowed the two men to continue the work in their spare time.

"The start of the Great Patriotic War in 1941 with subsequent air raids and the threat and then actual bombing of Moscow sped up the decision-making process: the State Defence Committee (SDC) issued a resolution 'On the construction of fighters with liquid-fuel rocket engines'."

Chief Designer, D. Sc. (Technology), Lenin and State Prize Winner A. Bereznyak:

"Our friendship was not based on frequent meetings or lively correspondence. Often all that was needed was a telephone call to learn how the other was doing, how his work was going, and, if necessary, to offer to help.

"We came to appreciate each other almost as soon as I transferred to work under him in the mechanism maintenance team. We became even closer after we began to work together on the interceptor project, which, at the decision of V. F. Bolkhovitinov, would later be known as 'BI' (from the first letters of our last names). At first just the two of us worked on the project—in the evening, late at night, and on our days off. But once the Bolkhovitinov Plant was informed of the SDC resolution, the entire collective worked on the project day and night. One month and ten days after the resolution was issued, the plane was rolled out to the air field.

"Throughout this entire time practically no one

left the plant. We snatched sleep whenever we could and stood guard on the roof of the building, extinguishing the many fire bombs German planes dropped when they failed to make it to Moscow. We also spent time digging trenches and tank ditches, and setting up antitank obstacles.

"This was how we lived and worked till the end of October 1941. At that time we received orders to evacuate the plant to the Urals. In a matter of days all the equipment had been dismantled and documents packed away. Aleksei Mikhailovich raced through the plant with everyone else, taking down machines and loading them into cars.

"On October 25 the convoy started on its way. On November 7 we arrived at our destination—an old, half-destroyed tube-casting plant without floors, windows or doors. We spent our first night in the only large building in the village—the church—sleeping on the floor. The next day everyone began to unload the cars and clean up the plant to make it fit for work as soon as possible.

"Our youth and the conviction that we were engaged in very important work for the front gave us inexhaustible strength, bolstered our confidence and kept us from despairing, even when things didn't always turn out the way we had hoped."

Chairman of the State Commission, Lieutenant-General V. S. Pyshnov:

"Feeling the acceleration of the 'BI', pilot Grigori Bakhchivandzhi began to increase the angle of ascent. From the ground, the plane seemed small. But the flame behind the nozzle continued to burn. At an altitude of 1,500 metres, the plane banked a turn. When it had nearly completed a semi-circle, the flame disappeared. The active phase of the flight was over. Now the plane glided soundlessly. It slowly descend-

ed and approached the runway. The landing was a little rough, and the small landing gear broke. Bakhchivandzhi was unable to make a good approach. In order to decrease his speed in time, he had to slide along the wing.

"When the plane finally stopped, it was immediately surrounded by a ring of people. The pilot was pulled out of the plane and carried. Many intuitively felt that they had witnessed a historical event."

Yuri Gagarin, the world's first cosmonaut:

"If Grigori Bakhchivandzhi had not made his flight, there would have been no flight on April 12, 1961."

A. A. Tolstov:

"The age of rockets had come. We were inundated with orders from the developing new industry. Isayev's group was not the only organization involved with engines, because many people were worried the new work in engine construction was extremely risky (there were certain grounds for this concern). Managers thought it necessary to have the work duplicated, so separate groups were formed to work on similar questions. But in time everyone realized that such duplication was unnecessary and our 'competitors' joined us.

"Here Isayev did everything he could to make the former 'competitors' feel like full and trusted members of the joint collective. He never hinted at a division between 'ours' and 'theirs', between the 'oldtimers' and the 'newcomers'."

A. V. Flerov, USSR State Prize Winner:

"In 1949 there was a rumour that we were going to join Isayev's group. We used to see him in the corridors, always wearing a worn leather jacket and with a smile on his face. His group seemed to be as casual

as he was—you had trouble figuring out who was the head and who were the subordinates.

"Just before the switch was made, we started to make inquiries about him. We weren't very happy when we heard him called a 'tyrant'. I tried to find out what he had done that was tyranical. It turned out that he had once reprimanded an engineer for designing a mechanism without first verifying that the necessary materials were available. As a result, they had to be ordered from outside and valuable time was wasted. But what really angered Isayev was the engineer's statement: 'It's not my problem. There's a state standard for the material: let them get it.' "

"This incident made a favourable impression on me. I, too, could not tolerate formalism. I waited to see what would happen.

"One day I was called up by Isayev who asked me if I had heard our section would be joined with his. I replied that yes, I had heard this. Then he asked me to be so kind as to come to his office.

"I went with, as they say, an uneasy heart. When I opened the door I saw a strange scene: ten or so people were sitting in a relaxed manner around a large table. I didn't notice Isayev right away. He was sitting to the side, straddling a chair faced towards him, and immediately got down to business:

"Describe the main employees in your section, not just their work but their personalities."

"I began somewhat nervously, but I gradually felt more at ease. Everyone seemed so good-natured. There wasn't a trace of anxiety left. Isayev concluded the conversation by saying:

" 'We'll get along fine.'

"And we did get along for more than twenty years."

V. F. Chebayevsky, D. Sc. (Technology):

"I think I was lucky: as a young engineer I worked under A. M. Isayev. We were a friendly family of enthusiasts working in a spirit of creativity, industriousness and dedication.

"We were the builders, and we were the ones to clean up the construction site. Aleksei Mikhailovich took part in all this. He would place someone else in charge and work with a handbarrow or shovel, or load barrels, trusses and cisterns.

"One Saturday when Aleksei Mikhailovich was helping in a general clean-up, he was told a scientific researcher from another institute was waiting for him in the reception area.

" 'Well, tell him to come here!' was the reply.

"A few minutes later a rather imposing gentleman dressed in a neatly pressed suit and carrying a mackintosh over his arm walked up. The two men greeted each other. When Aleksei Mikhailovich learned what his visitor was interested in, he told him:

" 'Hang your coat over that door and pick up the other end of this hand barrow. We'll talk as we work."

"The man could do nothing else but lend a hand. For about two hours the two men carried rubbish, sometimes stopping to draw something on the ground with a stick. They would disagree, discuss the matter, and once again pick up the handbarrow.

"I don't know what kind of agreement they reached, but I remember how warmly they said goodbye. The visitor left with a friendly smile on his face—it was clear he was pleased with how the meeting had gone and wasn't a bit offended. Maybe he was thinking: 'When I get back I'll tell them I made a personal contribution to the construction of the research facilities of Isayev's design bureau.

L. A. Pchelin, Lenin Prize Winner:

"I once worked with another design bureau. This

was how things were set up: each engineer was given an assignment and deadline for completion. If you finished on time, you got your bonus; if not, accordingly. And the bonuses, which were distributed each month, were quite large. After an assignment was completed, the blueprints were given to a control group which looked for errors, classifying them into eight categories. The first category, for example, pertained to insignificant mistakes—drawing a border of incorrect size around a blueprint, affixing a seal slightly askew, etc. At the entrance to the design bureau building, a chart was hung where an engineer's mistakes were listed beside his name. The result was that if you made a bad design of a unit and wanted to fix it, you were taking a big risk. If you didn't finish it on time, you could kiss your bonus goodbye. And if in haste you drew a border around a blueprint that was a millimetre off, you'd find yourself listed with the botchers. Clearly, it was no use trying to 'set the world on fire'. After all, it's easy to evaluate the quality of a blueprint, but it's virtually impossible to judge the quality of units that have never before been designed.

"Isayev's design bureau was quite different. The atmosphere was relaxed and friendly, and personal initiative was encouraged. Everything was conducive to creativity. We felt at ease, and the work was interesting. Aleksei Mikhailovich had the wonderful ability to get all his employees interested in a project. When he gave an assignment he never set a strict deadline. If the work was urgent he would say: 'As soon as possible. The deadline is yesterday before lunch.' Sometimes an engineer would get a better idea for designing a unit and tear down from the board the blueprints he had already drawn. Isayev wouldn't get angry, he'd merely ask: 'What are you doing?' 'It wasn't any good, Aleksei Mikhailovich.

I need to do it over.' 'And how are you going to do it over?' And the two men would discuss new engineering designs."

K. V. Adianov, A. D. Slashchev:

"We were sent to A. M. Isayev's enterprise to prepare for the testing of new parts. The day before we were to leave, Aleksei Mikhailovich phoned to say his ZIM (a model of car) would be waiting for us at the train station.

"The ZIM was indeed waiting for us at the station, and we quickly arrived at our destination. A meeting was already in progress in his office. When it was over we were taken to the shop floor. By the end of the day all the preparations for the testing had been made. We informed Aleksei Mikhailovich of this and then told him we wanted to go look for a hotel, promising to be back early the next morning.

" 'You don't need a hotel,' he said. 'Here is the key to a three-room apartment. I think it will serve your needs.' And he handed us the key and a piece of paper with his address on it.

"We, of course, were flabbergasted and insisted we wouldn't hear of it.

" 'Where do you think you'll find a hotel now? My apartment is empty: My relatives are at the country cottage. That's where I'm going. Meanwhile, you can rest without any bother or fuss. Take the bedclothes and blankets and have a good night's sleep. I'll see you at work in the morning.'

"We found the apartment quickly. It was as modest as its inhabitant."

Hero of Socialist Labour S. Ivanov:

"Sergei Pavlovich Korolev had faith in Isayev. And Aleksei Mikhailovich appreciated that. All the assignments were completed on time, "without a

hitch", as they say. It was no coincidence that Isayev's design bureau was assigned to develop the retrorocket system for the *Vostok*, the spacecraft that was to carry into orbit and return to earth the world's first cosmonaut. If the slightest error were made in the system design, the spaceship would either be the captive of the universe for all eternity or burn up in the dense layers of the atmosphere. And, whereas it was possible to have a back-up (even double back-up) automatic control system the *Vostok* construction design did not allow for back-up retrorockets. Isayev could not make a mistake.

"On April 12, 1961, Yuri Gagarin made his historic flight."

New ships and new cosmonauts continue to follow Gagarin's path into space. *Molniya* automatic communications satellites, *Meteor* meteorological satellites, *Progress* cargo transport ships, and *Salyut* and *Mir* orbiting research stations are exploring the mysteries of space. And each time a spaceship or satellite travels beyond the clouds, we are reminded of the pioneers of rocket technology, of those who stood at its threshold, who did everything to make space flights successful and a credit to the Soviet Union.

Launch after Launch

On October 4, 1957, what man had dreamed of for centuries became a reality. A powerful rocket lifted into orbit a device designed and constructed in the Soviet Union—the world's first sputnik.

Since that time people have grown accustomed to cosmic scales, to new understandings of speed, altitude and distance. The automatic devices launched into space have given scientists and researchers a store of information that has made manned space

flight possible. For many years such automatic machines have reliably served man, sometimes being the sole means by which he studied the universe. But it is man alone who, whether orbiting the earth or travelling on an interplanetary mission, has the capability to solve the riddles of the solar system. Once man acquired the ability to explore space as reliably and confidently as he did the earth's atmosphere, it was just a question of time as to when the first manned space flight would take place.

Any new undertaking presents difficulties, but the manned space flight programme was exceptionally complex. The Cosmonaut Training Centre that was organized in the Soviet Union was the first of its kind in the world, which meant that everything had to be built from scratch: the organization, training systems, simulators, etc.

General Nikolai Petrovich Kamanin, one of the Soviet Union's most distinguished aviators, was charged with heading the training programme. He would meet Yuri Gagarin and become the first cosmonaut's mentor. Yuri would turn out to be a worthy pupil.

General Kamanin liked to relate how he became a pilot: "I got my start in the Borisoglebsk Aviation School for Pilots—one of our Air Force's first military academies. Many men got their start in life there."

In November 1929 Borisoglebsk School graduation exercises were held. At that time there was fighting along the Chinese-Eastern Railroad, which White Chinese forces in Manchuria were trying to seize. So every graduating cadet was hoping to be sent to the Far East, to be in the thick of the fighting. Three young men, including Kamanin, were chosen. But by the time their mail-passenger train arrived at its destination 16 days later, the fighting was over. Nikolai Kamanin became a member of the Lenin

wing that had been transferred to that region. It was here that the young pilot really learned to fly. His comrades and the more experienced pilots frequently helped him out.

Kamanin was once told to fly a short mission over Lake Khanka. It was a night flight, and the sky was filled with stars. Kamanin felt alone in endless space; it was like a dream. Suddenly the pilot noticed that where the ground should be, according to his calculations, there were more stars. The water in Lake Khanka was reflecting their light. But to Kamanin, it seemed that there were stars everywhere—above, below, forward, to the right and to the left. The young pilot lost his head. He veered right and left at random, no longer trusting his intuition. Then he remembered the words of his commander: "Fly by your instruments."

But how could he trust those mechanisms if he was finding it hard to trust himself, when he felt he had lost all his pilot skill? He was frightened but managed to overcome his fear and fly by the instrument needles. And he survived.

This incident served the pilot well: he learned that he could not be an ace without experience and skill, just as he would have to improve his self-control. People like this are characterized by another quality: the ability to do the impossible.

Kamanin couldn't quite understand why he was named commander of the pilot rescue operation to save the members of the *Chelyuskin* expedition[1]. He

[1] The expedition headed by Otto Schmidt which in 1933 set sail aboard the Soviet steamer *Chelyuskin* to attempt a voyage across the North Sea from Murmansk to Vladivostok. In February 1934, the *Chelyuskin* was crushed by ice and sank. The people on board sought safety on the ice and were later flown to land by Soviet pilots.

was, after all, only 25...

When word went round the camp that efforts to reach Otto Schmidt by dogsled had failed and there was no hope of using icebreakers, Kamanin resolved to fulfil the rescue mission—there was no other way to save the people.

The flight to the Schmidt camp was long and difficult. Frequently Kamanin had to land to repair his plane. The pilot was facing the perfidious winds, severe cold and hummocks of the Far North. Finally he had flown to within a few kilometres of the camp. Impatiently he pulled back the cockpit hood and peered outside. The freezing wind burned his cheeks. Just ahead he could make out a black spot. A minute later he saw smoke, then a wooden barracks, a pole with a red flag and tents from which people came running, waving their arms and clambering over the hummocks.

Later Kamanin would recall the scene:

"As soon as I landed people surrounded the plane. I was just as emotional as they were. Then Otto Schmidt embraced me. He had tears in his eyes, but of course they were tears of joy. The people had believed in their country, believed it would make sure they were rescued. And I represented that Great Power. All this made the difficult trip worth it. This was what gave me strength."

Willpower and determination—these are two characteristics a pilot must have. And it was not by chance that pilots were to be the first cosmonauts: only the strong and able could penetrate the mysterious and inhospitable world of the planets and stars. Since the professional skills of pilots are similar to those of cosmonauts, they had a better chance of passing the stages of the recruitment than representatives of other professions.

Sergei Pavlovich Korolev, who could well under-

stand the soul of a military pilot, supported this opinion. He and Nikolai Kamanin developed a close friendship, which only helped their work. Kamanin was involved in the organization of the Centre right from the start.

Everyone participating in the Cosmonaut Training Programme tried to get the set tasks accomplished in as short a time as possible. Space exploration was being conducted at such a rapid pace that manned space flight, which until recently had seemed to be a distant goal, now appeared to be reachable within a matter of months. In March 1960 the future pioneers of the universe had already been grouped together in a single detachment. They arrived, greeted each other and almost as quickly began to study and participate in training exercises.

Even the novices had to run from one enterprise and organization to another asking for necessary equipment and class materials. After overcoming their initial uneasiness, all the members of the detachment began to make suggestions for teaching and training the cosmonauts. They discussed class curricula and training facilities, and each understood: time does not wait, what had to be done had to be done quickly.

The days of the future cosmonauts were filled: at the airfield, in the laboratories, in the classroom; planes, catapults, simulators. An extraordinary combination of exercises, extraordinary tests, extraordinary disciplines. Each new day was similar to the one before only in the early morning: rising, exercise programme and breakfast. The rest of the day was spent in entirely different activities, and for a good reason: during actual space flight the cosmonaut faced enormous risks.

Finally—a man in space.

Yuri Gagarin's flight proved the Cosmonaut Train-

ing Programme had been organized correctly: giving the pilot endurance reserve that would enable him to spend even more time in orbit around the earth. Gagarin coped very well with the g-load that accompanied the rocket's entry into orbit, and had no real problem with weightlessness during the flight or the gravitational pull he experienced when the rocket reentered the denser layers of the earth's atmosphere.

After Gagarin's flight, the cosmonauts, along with Sergei Korolev, spent some time relaxing at a sanatorium on the Black Sea coast of the Caucasus. Korolev informed the cosmonauts that the next spaceship, scheduled to be launched in August, would not make just three orbits but spend twenty-four hours in space.

Before making this announcement Korolev met with Kamanin and asked him:

"Do you think your pilots can do even more?" He was referring to the amount of time spent in space.

Kamanin replied he thought they could and asked how long Sergei Pavlovich thought the next cosmonaut should spend in orbit. The Chief Designer answered:

"Twenty-four hours—seventeen orbits. It will be difficult. But it will be a great leap forward for us."

Kamanin expressed his doubt:

"The physiologists will strongly protest it. There will be a war with the doctors."

"We can't be afraid of taking risks, as long as we have grounds for believing in the mission's success. We'll meet with the pilots and let them decide."

The meeting was held and a few months later Gherman Titov orbited the globe seventeen times.

After the *Vostok-2* flight, *Vostok-3* and *Vostok-4* were launched. And in June 1963 Valery Bykovsky in *Vostok-5* and Valentina Tereshkova (the first woman in space) in *Vostok-6* went up.

This is how Nikolai Petrovich Kamanin describes these launches and preparations for them:

"11 June. Baikonur. 5.00 a.m.

Only two weeks have passed since I left Moscow, but it seems like an entire year. There is so much work...

The weather has been good—no hotter than thirty degrees. Usually the thermometer shows more than forty in June.

Yesterday at 22.30 I received some important information: solar activity had sharply increased, and it is expected that the radiation level in the earth's orbital sphere will increase as well. At an emergency meeting called by Academician Keldysh, many of the scientists urged postponing the space venture. At a meeting of the State Commission, we came to the same conclusion. So the world will have to wait to find out the name of the first woman daring enough to travel to the stars... It has already been decided who will be the principal candidate for the launch and who will be her back-up...

Safeguarding the cosmonauts from radiation has been a matter of great concern. And with good reason. Space is penetrated by all kinds of radiation, the lethal effects of which man is protected from by the earth's dense atmosphere. It is still not entirely clear how to protect the orbiting spaceship from the effects of cosmic rays.

Unfortunately, sometimes people can make a dangerous situation even worse. A year ago, on July 9, the US exploded an atomic device in space, and a few months later conducted another atomic test. The resulting radioactive cloud came close to harming American astronaut Walter Schirra, who was in orbit at the time. It is hard to comprehend such actions by the US Government.

In May 1962 Gherman Titov and I were in Amer-

ica. Our trip was filled with appearances and meetings. I remember our meetings with the astronauts. They were modest men, dedicated to their profession. One day John Glenn invited us to his house for dinner. He lived 60-70 kilometres from Washington in a modest, two-storeyed house. We arrived when Glenn's family (his wife and two children) was at work. The table was quickly set, and we were served "specialties of the house". The famous astronaut said his dream was to travel to other planets.

A few days later at a scientific symposium where both Glenn and Titov spoke, the two men were given an unusual present—large Dutch clogs. As they were given the gift, they were told:

"Mr. Titov and Mr. Glenn, these clogs were made out of the same tree. It would be wonderful if they always walked together." Gherman was given the left clog, Glenn—the right.

June 14. A remarkably sunny and quiet morning. Instead of exercising I swam for half an hour in the river. I felt strong and invigorated afterwards. Today, of all days, I will need to be.

This is the day Valery Bykovsky will be launched into space aboard the *Vostok-5*. A few days later, a woman-cosmonaut will be launched. The solar activity has stabilized, and there are no obstacles to hinder the venture.

Two hours and fifteen minutes before the launch, a bus drove the cosmonauts to the rocket. The back-up cosmonaut stayed on the ground while Bykovsky rode up to the top of the rocket in a lift. Now began the most crucial phase—the last verification before the launch. A forty-minute countdown period was announced.

June 15. Slept about two hours. I was on duty at mission control. Bykovsky's flight is proceeding normally. But Bykovsky has already given us a scare.

During one of his orbits, he stopped answering our calls. We hooked up the television connection and saw him. The telemetry showed a pulse rate of 54 beats per minute. We had begun to worry, but on the next orbit we learned that Valery had just gone to sleep ahead of schedule...

It was a sleepless night I spent at mission control with Korolev. He has looked pale and wane these past few months. The tension of the work is having an effect. Not too long ago Sergei Pavlovich was seriously ill. For several days he ran a temperature of just under forty. The doctors recommended strict bed rest: his lungs were inflamed. But how could he forget about work when there was a launch scheduled shortly? From morning till night the phone rang in his room, and Korolev talked until he became hoarse.

I was asked to intervene. I tried to tell him the sooner he got well the sooner he would be on his feet and could return to work. But Korolev merely answered: "By the way, I also want to go up in space. But you, Nikolai Petrovich, have become a bureaucrat. You don't even think about flying."

It was a strange conversation. I tried to tell him a cosmonaut must be in excellent health and young—no more than forty. And he argued the opposite. The result of our disagreement was that his temperature rose. I walked back to my hotel room, regretting that I had been unable to carry out my mission. And I understood that, in principle, the Chief Designer was right. Later the requirement for ideal health would be lifted. As for my wish to fly, I would have given anything to fulfil it...

June 16. At exactly 12.15 the bus drove Valentina Tereshkova to the launch site. She had been selected by the State Commission to take the cosmonaut's chair in *Vostok-6*. At the base of the rocket she was

given some flowers, which she in turn presented to Korolev.

The papers and magazines had a field day when the TASS report about Valentina's flight came over the wires.

June 20, Kuibyshev. Today at 11.30 the planes that had picked up Valery Bykovsky and Valentina Tereshkova arrived. The cosmonauts had fulfilled their flight missions with great success and deserved to relax. But what kind of relaxation could there be when the entire world was in a frenzy? The cosmonauts were sent tens of thousands of telegrams and letters.

Thousands of people came to meet Valya and Valery at the airport. Of course they found it impossible to contain their excitement. They broke through the barriers and swarmed around the cosmonauts.

At 15.10 Tereshkova informed the State Commission: "The launch went well; the pull was less than five g's. After entering orbit, I saw the earth from the left porthole, and from the right—the third [rocket] stage. I experienced no unpleasant sensation in making the transition to weightlessness... I photographed the earth, clouds and the moon.

"I could see thunderstorms over South America. At night I could easily distinguish the cities by their lights...

"The first twenty-four hours I didn't feel the weight of the spacesuit. But the second day, my right knee began to ache. The helmet bothered me, and was pressing against my shoulder. I got headaches from the telemetric sensors attached to my head...

"The bread was dry so I didn't eat it. I wanted some ordinary brown bread, potatoes and onion. The water was cold and tasted good.

"The retrorockets fired smoothly. I flew towards

the earth backwards. The ship was steady, but occasionally it rocked. The pull was approximately eight g's. When the *Vostok* was burning in the dense layers of the atmosphere, flakes flew past the window.

"I landed on soft ground. Immediately people came running up to help me."

Valery looks good, Valya—a little tired. They did a great job in space. It's nice that we didn't make a mistake in choosing them...

Korolev is in a good mood. Once he introduced me to an audience this way: "Now to speak is one of the first Heroes of the Soviet Union, my best friend, who hardly ever becomes upset, even in the most difficult situations. And if he does become upset, just a little..."

When we were alone he asked me: "On to new work?"

In all honesty the leader of the mission was cosmonaut-pilot Valery Bykovsky. He was in space almost five days, his ship making eighty-one orbits around the globe and covering a distance of more than 3,300,000 kilometres. It was only natural that he set this record. While still in his aviation unit, Bykovsky revealed himself to be a fighter-pilot undefeated in air battle and the interception of air targets. His work references contain many noteworthy comments. For example: "He fights energetically in battle and knows strategy", "He endures g-load very well", "He is extremely good at intercepting air targets". The members of the Commission who selected pilots for the Cosmonaut Training Centre showed an interest in these qualities noted by the young officer's flight trainers. And they were not mistaken. During his training for space flight, Bykovsky showed himself to be a courageous officer who easily mastered space technology. He was entrusted

with carrying out the most difficult space venture of all, and he fulfilled it honourably.

With her remarkable flight aboard the *Vostok-6* spacecraft, Valentina Tereshkova increased the prestige of Soviet women workers. Valentina confidently passed the extensive specialized training programme. Like the male cosmonauts, she went through all the trainning sessions and tests—in the rotation device, centrifuge, altitude, temperature and isolation chambers. She flew in the cockpit of planes, learned how to control the plane wings and a parachute. All in all, Tereshkova successfully passed the entire cosmonaut training course. She developed in herself those qualities necessary for making an orbital flight. Like Bykovsky she fulfilled her mission very well.

The single-manned *Vostok* spacecraft performed successfully in space. But the time came when more modern rockets appeared on the launch pad in Baikonur—the *Voskhod* ships, which could contain an entire crew. The *Voskhod-1* flight, in which Commander Vladimir Komarov, scientific researcher, Cand. Sc. (Technology) Konstantin Feoktistov, and medical doctor Boris Yegorov took part, marked the beginning of a new stage in the work of cosmonaut crews.

A unique experiment was conducted aboard the *Voskhod-2*; for the first time in history a man walked in space. It happened on 18 March 1965. The legendary crew of the *Voskhod-2* was in orbit just over twenty-four hours. But this was long enough for cosmonauts Pavel Belyaev and Aleksei Leonov to enrich space research by their truly great accomplishment.

Scientists, space technology engineers and cosmonauts had long been interested in the possibility of man's walking in space. If no danger to human life existed outside a spaceship, if he could easily move around in the airless environment and conduct

work there, the gates to space exploration would be, figuratively speaking, thrown wide open. There would be the possibility of replacing the ship's worn-out exterior equipment, repairing it in space, and helping crews in distress. Most important, it would be possible to assemble in orbit an entire space train composed of transport cargo ships and scientific stations.

There, outside their ship, was a vast area of cosmic questions that no one before had ever touched upon. It was up to Leonov and Belyaev to invade this as yet unknown world. They did everything to ensure the successful outcome of the experiment.

Saying goodbye to Leonov, Sergei Korolev said: "Just leave the ship and then immediately go back inside—nothing more." This one sentence spoken by the Chief Designer said a great deal: space was still largely unknown. Anything could happen.

Leonov spent a few minutes in open space at a distance of up to five metres from the ship. His connecting line to the ship was like an umbilical cord, feeding him life. Commander Pavel Belyaev tensely observed the space travel of his comrade, listening to the crackling of the static in his earphones and the thumping sound made by Aleksei when he brushed against the side of the ship. The experiment went smoothly, strictly according to plan. But it could have been different...

It can be said of Pavel Ivanovich Belyaev that he lived his entire life never wasting a single minute, dedicating himself to fulfilling his dream of space exploration. He was a teenager during the Great Patriotic War. Like all his peers, Pavel dreamed of the front. He applied to the Military Commissariat many times and volunteered to be sent to the front. But he was never accepted. He was too young. He did manage to get what he wanted, however. He was sent

to an aviation academy.

He became a pilot and then a cosmonaut after he demonstrated an interest in unusual flying missions. As a member of the first group of cosmonauts, Belyaev diligently and thoroughly studied the new space technology. He trained for space flight and at the same time helped his fellow cosmonauts. Soon he was selected commander for the *Voskhod-2*.

Aleksei Leonov was just a boy in distant Kemerovo when the war began. But even there he felt its breath. A large number of wounded were sent to that small town in Siberia. Aleksei met them at the station and later helped out in the hospital wards. His artistic ability was demonstrated at an early age. The simple paintings he drew as a child were generously presented to the neighbours. Aleksei was very interested in painting, but he didn't change his choice of profession—it was aviation all the way. After graduating from the academy he served as a fighter pilot. It was in his aviation unit that he was noticed by the cosmonaut selection committee.

Leonov has many good qualities: friendly, inquisitive, and with the ability to notice details, analyze a situation and draw conclusions. According to Sergei Pavlovich, it was Leonov's natural gifts that led to his being selected a member of the crew that would be responsible for carrying out a fundamentally new mission. And the selection was completely justified, just as it would be in the future when he lived up to the hopes placed in him as a member of the Soviet No. 1 crew and participant in the international *Apollo-Soyuz* programme. For this second feat in space Leonov was again presented the highest award of the International Astronomical Union.

But that would be later, in 1975, when the cosmonauts would have *Soyuz* transport ships and *Salyut* long-term orbiting stations. In 1965, how-

ever, Pavel Belyaev and Aleksei Leonov flew the last *Voskhod*.

The utilization of more modern space technology marked the beginning of the next stage in space exploration.

Each rocket launch represented a significant step in the process of understanding the universe and in the development of the space programme. The Cosmonaut Training Centre began work on a new model of spaceship—the *Soyuz*.

The *Soyuz* was a much different type of ship than its precursors. It was more modern in every respect with the ability to launch into orbit a crew of two or three cosmonauts and allow them to work in space for a prolonged period. Working in conjunction with the *Salyut* scientific orbiting station and other similar spacecraft, the *Soyuz* was capable of carrying out serious scientific and technical tasks. It had a docking device that would allow it to hook up with other space vehicles, long-range radar equipment. No other ship had ever had such devices. The *Soyuz* was equipped with additional, fundamentally new instruments, and these, together with the docking device, made the ship significantly more modern, even unusual.

In December 1966 a working docking device was brought to the Cosmonaut Training Centre. The cosmonauts, who had been divided into first and back-up crews, began a new training programme. Each group had its own specific and detailed flight plan.

The Centre had already been operating for six years. It had become a well-organized institution, and its team of experts continued to make scientific advances. The programme used to train the cosmonauts for the *Vostok* and *Voskhod* missions was studied in detail and further developed; new doctors and candidates of science joined the work team; the

cosmonaut-pilots themselves engaged in scientific research. Much was done to improve the Centre's training facilities, and new forms and methods of training were introduced to prepare the cosmonauts for the *Soyuz* flights.

The first launch drew near. Since the ship was new, the first flight was in many ways a test. One of the most well-trained cosmonauts, Colonel Vladimir Komarov, was selected for the mission. The world first heard his name two and half years prior to that time when he flew aboard the *Voskhod*. Afterwards Komarov had worked very hard, learning everything about the *Soyuz* and its complex equipment. He had spent many training sessions in the simulator and working with other special equipment. He had learned the ship well, acquiring the necessary knowledge and skills to fly it. His years of study at the Zhukovsky Air Force Engineering Academy helped him to gain a deep understanding of the new technology.

Vladimir Komarov was the first of the Soviet cosmonauts to be launched into space a second time. He faced the difficult mission of testing the *Soyuz* spacecraft. The launch took place on April 24, 1967.

Three weeks earlier, at the beginning of the month, the cosmonauts met as usual to give an account of their training. Speaking at the meeting, Yuri Gagarin stressed the difficulty of the coming flight aboard the new manned spacecraft, saying that there would be new aspects to the flight never before encountered, and that the cosmonaut would have to mobilize all his will, knowledge and skill to carry out his mission.

"It is virtually impossible to foresee everything," said Gagarin. "It is evident that independent decisions will have to be made during the flight. And the efficiency of the cosmonaut during the flight will depend on his state of preparedness.

Vladimir Komarov was well prepared for the flight. He ran a full test of all systems while in orbit. After completing his mission, he began to bring the *Soyuz* out of orbit, confident in a successful outcome. The ship performed well in passing through the most difficult period of deceleration in the denser layers of the earth's atmosphere and completely shut down rocket speed. But when the main parachute opened at an altitude of seven kilometres, the lines became tangled, and the ship descended too rapidly. This resulted in the death of the cosmonaut.

Despite the tragic outcome of its first flight, Gagarin spoke highly of the new spececraft. Like the other cosmonauts, he thought the *Soyuz* was an excellent, modern ship with a great future. Gagarin did not want any unfounded suspicions to compromise the new spacecraft. He defended it at every opportunity and himself prepared to fly it.

The engineers made some improvements and increased the ship's reliability. Soon another cosmonaut was sent up to test it—Hero of the Soviet Union and Merited Test Pilot of the USSR Georgi Beregovoi. When he first arrived at the Cosmonaut Training Centre, some of the employees thought he was just a visitor or perhaps the representative of some aviation unit sent to the Centre on business. After all he was 44 years old and rather heavy. But one day he was introduced to the cosmonauts as their new colleague.

Beregovoi faced a difficult task: getting fit for space. Each morning he was on the track, using the exercise equipment and trampoline. He was very energetic and unusually industrious. Six months later Beregovoi had reacquired his youth: he had lost almost ten kilogrammes, developed agility, and could skillfully perform on the exercise equipment. He was just as energetic in learning space technology and in

working with the simulators. The Commission gave him the go-ahead for the *Soyuz-3* launch in October 1968. Georgi Beregovoi conducted a wide range of experiments aboard the new ship. Using both automatic and manual controls, he approached another *Soyuz* ship, this one unmanned, and positioned his own ship in space. After stabilizing his position, he turned on the *Soyuz-3* engines and then fulfilled even more experimental operations.

The morning of October 30, after four days in orbit, Beregovoi confidently brought the ship down for a landing. The descent from orbit was controlled and the landing was soft and accurate.

The rewards of space flight increased significantly during the era of long-term orbiting, and it was now possible to seriously study the solar system. On the other hand, even though scientists are optimistic in predicting future space flights, it is clear that not all the problems have been solved. Lengthy flights entail a number of complexities which must be overcome.

The Number One enemy remains weightlessness. In conditions of space, the term "weightlessness" is relative. One can think of the station and the cosmonaut inside as both being in a condition of free fall under the influence of the earth's gravity. They fall with equal acceleration, but due to the high speed of orbit, "miss" and fly past the earth. All the parts of the body and objects inside the station move at equal speed, and forces are balanced. This is how "objects" and "surfaces" act when there is actually no weight. This gave rise to the use of the term "weightlessness".

Under such conditions the brain—the organ that coordinates and controls man's actions—receives unusual bits of information. The sensory organs react normally under the earth's gravity. But under

weightlessness, the signals from the skin, subcutaneous cells and blood vessels change. The brain must try to understand correctly and utilize these signals, assimilate and coordinate them. After long periods of weightlessness, muscles forget to work to keep the body upright as they do on earth.

Weightlessness develops new skills of coordination previously undreamed of: the ability to float and work suspended in the air. And this is not the mere restructuring of man's physiology and psychology. Cosmonaut Valery Ryumin said in one of his radio transmissions: "Weightlessness teaches orderliness. If you fail to put something where it belongs, you'll spend a long time looking for it."

As the cosmonauts become used to weightlessness, they develop new coordination skills. They become *quicker, more accurate and confident.*

The already great experience acquired in space flight reveals that long-term weightlessness most affects the functioning of the cardiovascular, bone and muscular, metabolic and circulatory systems. Thus scientists have spent considerable effort in trying to neutralize this effect.

During their lengthy space flight, cosmonauts Alexander Ivanchenkov and Vladimir Kovalenok took samples of their own blood. The tests revealed a moderate decrease in the erythrocyte and hemoglobin count, considerably less of a loss than what had been noted in previous flights. This positive result was connected with the cosmonauts' using a wide range of prescribed methods to preserve a sufficiently high volume of blood circulation (which in part is affected by the amount of water intake and physical exercise).

One other fact should be noted: most people try to get rid of excess body fat. In space an individual involuntarily loses weight as a result of dehydration

and a decrease in muscle mass. And this is by no means healthy. Interestingly, after spending 185 days in space, Leonid Popov and Valery Ryumin not only did not lose weight but, for the first time in the history of space flight, actually gained weight while in orbit: the commander put on an extra 3,200 grammes, the flight engineer—4,700. Both had an excellent appetite, and both drank up to two litres of water per day, mostly hot water. The volume of calf muscle did not decrease by as much as that noted in cosmonauts during previous flights, and the muscular strength of the arms increased. The commander could squeeze five kilogrammes more with his hand than before the flight, the flight engineer—eighteen kilogrammes more. This was a good sign for the future.

Weightlessness also causes a change in taste. Usually the cosmonauts are given rations wrapped in individual packages. Every six days the menu changes. But the cosmonauts' requests for food are granted whenever possible. Items of food are sent to them by transport ships and they are permitted to eat what they want from the store of food on board the ship. The cosmonauts are reminded to drink and eat sufficiently, because living in space dulls feelings of hunger and thirst. And if a body drinks an insufficient quantity of liquid, this is immediately reflected in the volume of circulated blood, which directly influences the quantity of erythrocytes, volume of the heart chambers, vessels and other systems. All these things are closely interconnected.

An interesting phenomenon is observed. Once a body has experienced weightlessness, it somehow remembers it, making the second adjustment much easier. This condition is being studied both theoretically and experimentally. The influence of gravitation on the development of the organism is being

studied not only in space flight but also on the ground. For example, in one experiment, scientists increased the gravitational pull—creating a condition of hypergravitation. For several months, starting right from birth, animals were spun around in a centrifuge. For them, increased gravity was ordinary. Simultaneously, a control group of animals observed. The test animals which lived in a world of increased gravity were smaller than those in the control group, but the absolute weight of their bones increased. This corroborates the theory of the linkage between gravitation and growth.

Some scientists have suggested that since, as we have already noted, the sense of taste and feelings of hunger and thirst are dulled in space, perhaps other senses are heightened. And, in fact, cosmonauts sometimes report they can observe objects on earth which would ordinarily be impossible to distinguish at such a distance. Apparently visual acuity remains the same, but this effect is produced due to changes in the optical properties of the atmosphere. This phenomenon requires further study.

Life in space is not easy. And no matter how carefully a crew is trained, something unexpected can always happen. For this reason it is important that cosmonauts have quick reflexes and various work skills. The training programme on earth requires the development of these skills as well. For instance, before Gagarin's flight, approximately one thousand tests were made on the *Vostok*. Four times that number were made on the *Voskhod-2*, and even more on the *Salyut* space station.

The space research programme in the USSR and abroad continues to develop—from automatic earth satellites equipped with simple instruments and capable of performing only the most uncomplicated scientific tasks, to complex space equipment and

manned space flight; from manned spaceships with a limited flight programme to long-term scientific orbiting stations with rotating crews—space laboratories equipped to handle the most sophisticated research and experiments for scientific and economic purposes.

Another point of interest concerning the cosmonauts: unlike aviation pilots, they cannot make test flights into space. A cosmonaut is launched into space for the first time without an instructor and after only training in a simulator. Nonetheless, he must perform all the tasks envisaged by his flight programme. This is why exacting requirements are made on the forms and methods of training the cosmonauts.

In the first phase, all cosmonauts in the same detachment are trained in accordance with a single programme. They are taught the fundamental theories of space research, study the construction of manned spececraft and their systems, make training flights in planes and parachute jumps, and participate in a programme of physical and medical-biological training. This general space training lasts approximately two years.

During the second phase, the cosmonauts begin to train in crews in accordance with the specific programme of the upcoming flight. The principal crew as well as one or two back-up crews are trained for the same programme. While engaged in specific flight training, the cosmonauts study in detail the systems, scientific equipment, and flight programme of the spacecraft they will be flying. They must learn to operate the spacecraft and all its systems, to develop a close working relationship between themselves and also with the flight controllers and those working in logistics.

Flying and parachuting are important in both phases of the training. These exercises develop

aptitudes necessary for space flight: psychological readiness for difficult conditions, emotional stability, and the ability to quickly make the best decision.

Flying a plane can serve as a distant model for space flight. When operating a fighter, the pilot orients himself in space, conducts radio transmissions, evaluates the situation and frequently has to make quick decisions.

Health requirements for the future cosmonaut trainee can be compared to a very fine sieve. Obvious illnesses and problems that could rule out participation in the space programme, for example, vestibular disturbances, are uncovered through an outpatient programme. In-patient tests are done to discover any hidden illnesses which may not show any outward symptoms or be accompanied by complaints but which could manifest themselves during flight.

Even after making sure that the candidate is in good health, it is important to check his reaction to different tests and reveal the limits of his functioning. A battery of tests has been devised for this purpose. It is possible to evaluate the functioning of the cardiovascular system, the vestibular apparatus and other physiological systems. These tests are conducted in the centrifuge and the pressure chamber and with special medical instruments.

Psychological testing is very important in preparing the cosmonaut for flight, for it can reveal how the cosmonaut will act in unusual circumstances, whether he will reveal positive or negative emotions, if he will act in a calm and collected manner or give in to panic.

Under the mattresses in the beds where Yuri Gagarin and Gherman Titov were sleeping the night before the first space launch, doctors had placed sensors which were to provide information about the cosmonauts' sleep patterns. Peaceful sleep would

be indicated by an even curve, a broken curve would show restlessness.

They say that Sergei Pavlovich Korolev, who stayed in a house close to the cosmonauts' got up four times during the night to check on the recording device (that was outside). He was amazed to see how peacefully the cosmonauts were sleeping.

"If I had been in their place I would never have been able to sleep that soundly," he commented.

With the development of space technology, the need to test it in space, and the growing complexity of scientific research, it became necessary to include engineers and other specialists in the space crews. These individuals were called flight engineers and cosmonaut-researchers. It became necessary to adopt a more flexible approach to the selection and training process of this new group of candidate cosmonauts. By space medicine standards, these were "no longer young" individuals who were not in the best physical condition. So before a final decision was made, these candidates underwent a "cure" to improve their health.

Though the future cosmonaut might acquire a good deal from the centrifuge and the temperature chamber, he would not go far without regularly participating in sports or physical training, which included a vigorous morning exercise programme and team sports such as football, volleyball and basketball plus acrobatics and swimming.

Many examples can be cited to demonstrate the cosmonauts' endurance and strength of character. Take, for instance, Vladimir Kovalenok. Training for the launch of the *Soyuz-25* spaceship, the cosmonaut was working out on a bike exerciser. One day he noticed he was working harder than usual, and the doctor noted an increase in his pulse rate. But, since he was a man of discipline, he completed his work-

out. Later it was discovered that the pedals had been set to turn at maximum resistance, much more than usual. This incident reveals not only the character of the cosmonaut but also his excellent physical condition. Something similar took place with another member of the crew—Valery Ryumin. While mountain climbing, he kept up with his guide. But Ryumin was also carrying a backpack containing lunch for the entire group and weighing twenty kilogrammes.

Another medical factor should be taken into account. This is what doctors refer to as "psychological compatibility".

Cosmonaut Aleksei Gubarev explains:

"You can be reborn in space. I experienced this during my flight with Georgi Grechko in 1975 aboard the *Salyut-4* space station. Working in conditions of weightlessness is very difficult, especially at first when one has not yet completely adapted to it. During this time one observes certain deviations from the norm: you don't feel well, you become extremely tense and in general feel uncomfortable.

"So, the first three days of our work in orbit Georgi and I got along just about the same as we did on earth (we were friends). We had business-like, cordial relations—the best for getting work done under such conditions. A few days later we began to feel more irritable. Sometimes there was a discrepancy in our evaluations of the same event. I soon noted that Georgi had become short-tempered and edgy. But on earth he had been known for his self-control, modesty and equanimity.

"Some people will say, 'But what about your training? Isn't it supposed to prepare you for that?' Maybe. But this never happened to us in the simulator on earth.

"We both tried to overcome our new nervous

condition. We had to smooth out the rough edges, so to speak, to forgive and accept the unusual behaviour of the partner. We were for the most part successful...

"I think that this will be even more of a problem for future space expeditions."

Each space flight is a test of new space technology. Also, it should be remembered that the cosmonaut does not merely register occurrences and admire the beauty of the galaxy. He analyses information obtained by the ship's systems, evaluates situations and is called on to react quickly to different situations. The ideal cosmonaut has a perfect knowledge of the ship's instruments and is able to operate all its systems. In short, he must be an experimenter. And with each flight the mission of the researcher and experimenter becomes more complex.

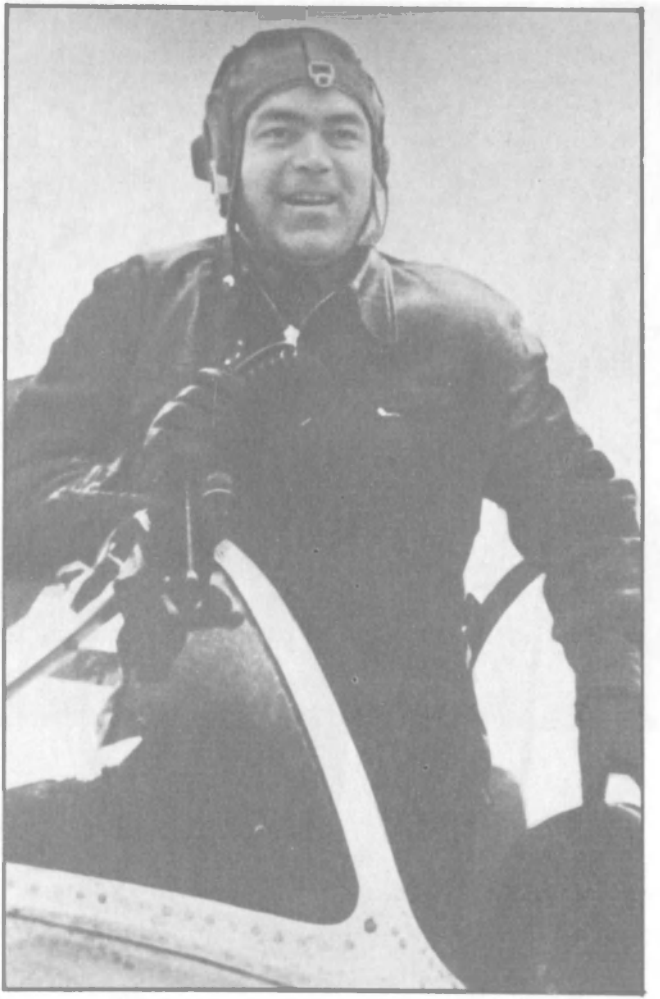
As has already been noted, orbiting stations have made it possible to conduct a significant number of different tests and experiments. It was aboard such stations that successive records were set for man's length of time in space. As manned flights have increased in duration, the number of experiments conducted aboard the station has also grown. New experiments required new energy. But where to tap it? When some experiments were being conducted, it was possible to conserve some electricity at the expense of other "users". But another method had to be found. It was clearly not feasible to have a *Progress* cargo ship deliver charged batteries. Experts suggested equipping the station with new solar batteries. But this would have required construction and assembly work in open space, something which had not yet been tried in the history of manned flight.

Aboard the *Salyut-7*, Vladimir Lyakhov and Alexander Alexandrov prepared to venture out into outer space. The cosmonauts had carefully adjusted

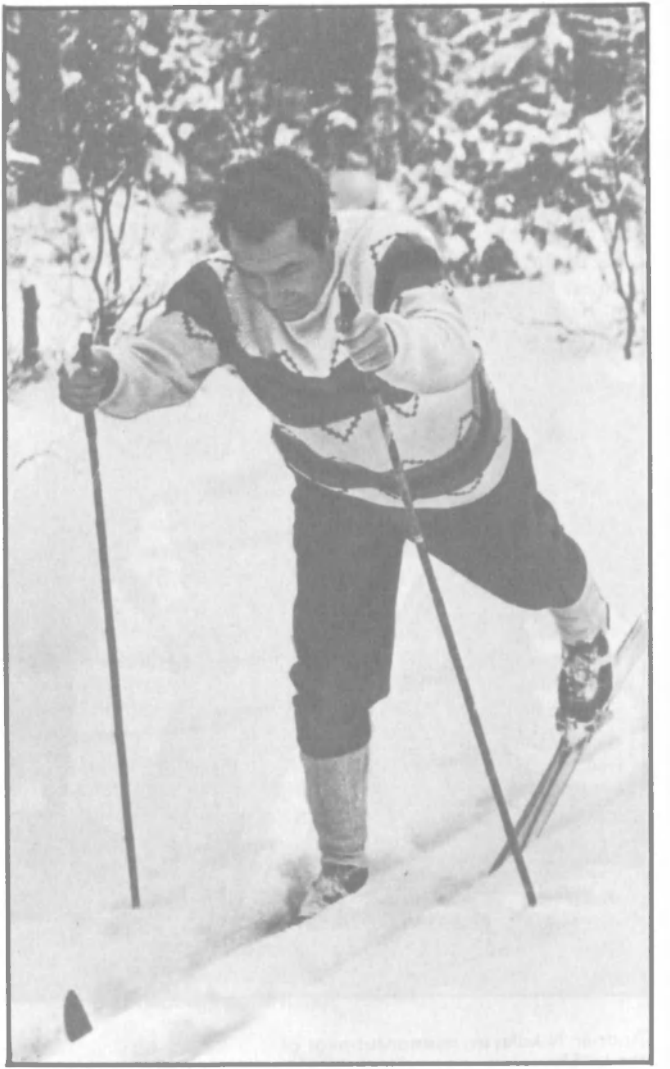
the spacesuits left behind by Anatoly Berezovoi and Valentin Lebedev. The importance of accurate adjustment cannot be overemphasized—space allows for no mistakes.

The decisive day arrived. The "Protons" (the code name given the cosmonauts by mission control) went into the adaptor module and closed off the hatch which kept the living quarters of the space station hermetically sealed. When the command came from Flight Control Centre, the men opened the hatch into space. The first to leave the orbiting station was flight engineer Alexandrov. He hooked up the portable television camera which would allow earth to watch the cosmonauts as they worked. The people at Flight Control would not only be observing the cosmonauts' activities but also carefully analyzing them and comparing them to the movements used to assemble a solar battery on earth. Commander Lyakhov came out to assist the flight engineer. The station was now empty; the *Soyuz T-9-Salyut-7-Progress-18* orbiting complex was now bieng operated by Flight Control.

While one team of experts at the Centre was controlling the orbiting complex, another, consisting of all manner of specialists, from engineers and designers to doctors, was observing the major event—the assembly of a new solar battery panel. The cosmonauts' movements were very slow. Even what seemed at first to be a simple operation took several tries to complete. This was the effect of weightlessness. Nonetheless, the two cosmonauts worked with perfect precision. It was evident that the training they had undergone in the hydraulic pool at the Training Centre in Star City (where conditions of weightlessness were simulated) had paid off. They removed the pleated solar battery from the container. Flight Control issued a command:



Andrian Nikolayev, cosmonaut-pilot of the USSR



Gherman Titov, cosmonaut-pilot of the USSR, skiing

Gherman Titov and his back-up, Andrian Nikolayev, head for the launch pad. Baikonur cosmodrome, August 6, 1961

Gherman Titov and Andrian Nikolayev, cosmonaut-pilots of the USSR

Cosmonaut-pilot of the USSR Pavel Popovich in space aboard the *Vostok-3.* August1962

Cosmonaut-pilot of the USSR Vladimir Komarov in preflight training

Cosmonauts Yuri Gagarin, Gherman Titov, Valentina Tereshkova, Andrian Nikolayev and Pavel Popovich, 1964

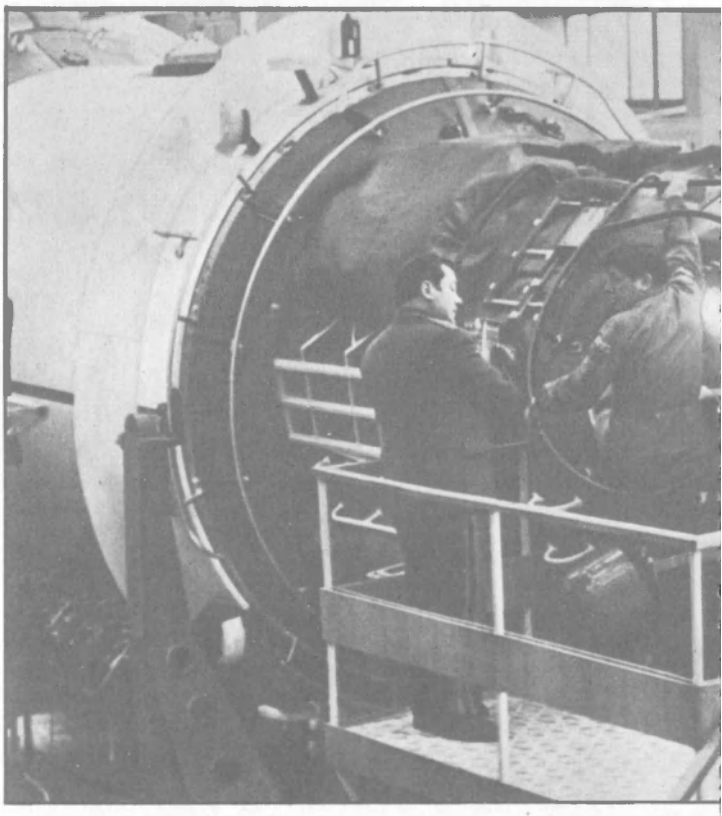
Cosmonaut-pilots with General Nikolai Kamanin and General Leonid Goreglyad

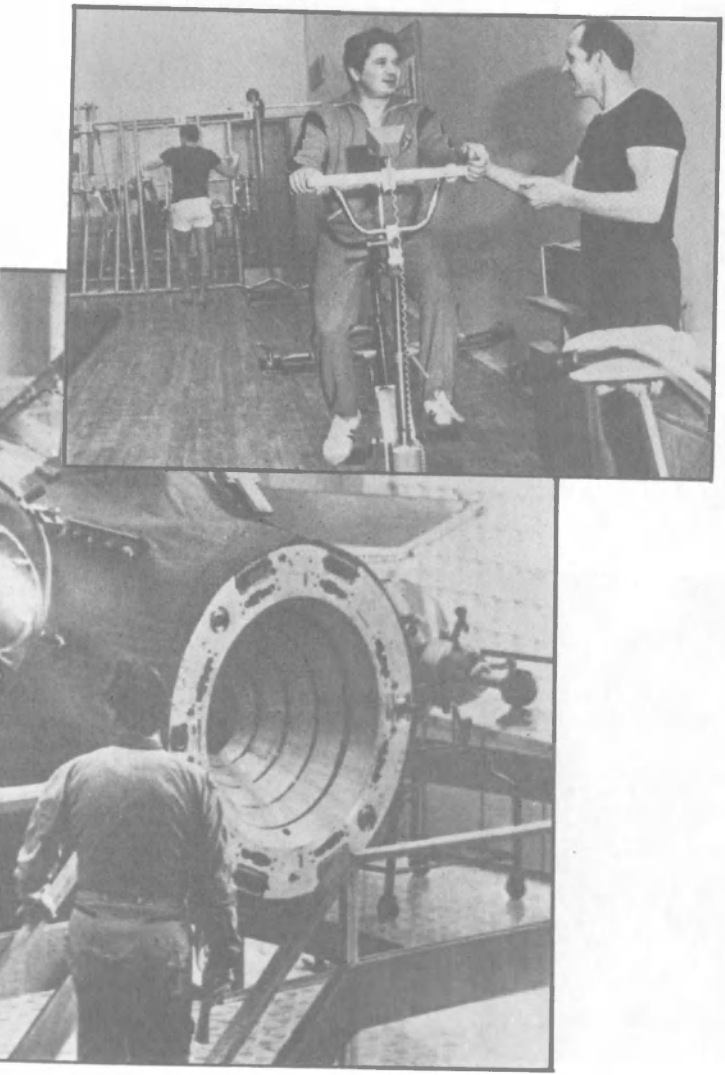
Cosmonaut-engineer Aleksei Yeliseyev describes the operation of the landing capsule to future cosmonauts

Cosmonaut-pilots of the USSR Aleksei Leonov and Valery Kubasov

Cosmonauts-pilots of the USSR Pavel Popovich and Vladimir Lyakhov exercising in the space station

Cosmonaut-pilot of the USSR Leonid Kizim at physical training exercises





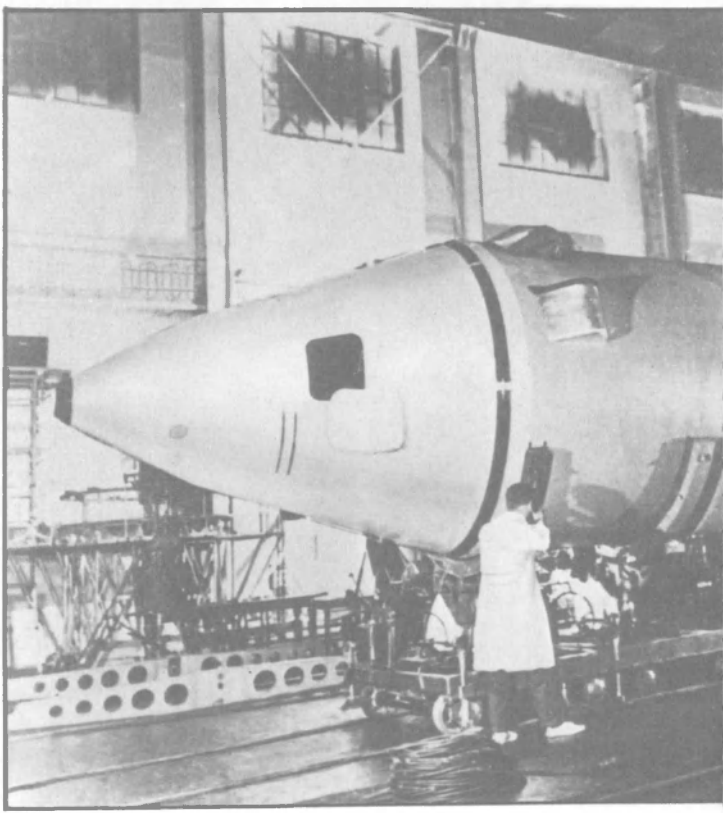
Cosmonaut-pilot of the USSR Georgi Beregovoi, twice Hero of the Soviet Union

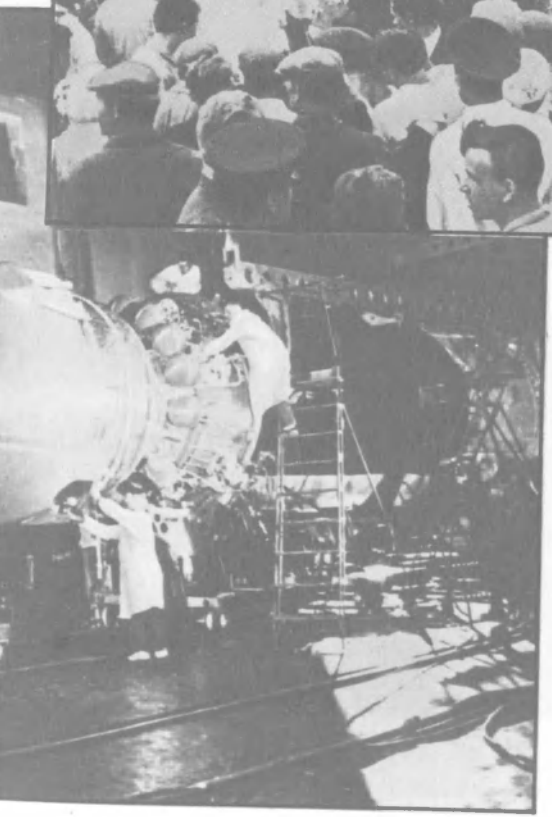
Cosmonaut-pilots of the USSR Vladimir Dzhanibekov, Svetlana Savitskaya and Igor Volk at a press conference

Cosmonaut-pilot Gennadi Strekalov in preflight training at the *Salyut* station

The assembly of the *Vostok* spaceship at the cosmodrome's assembly-testing building, April 1961

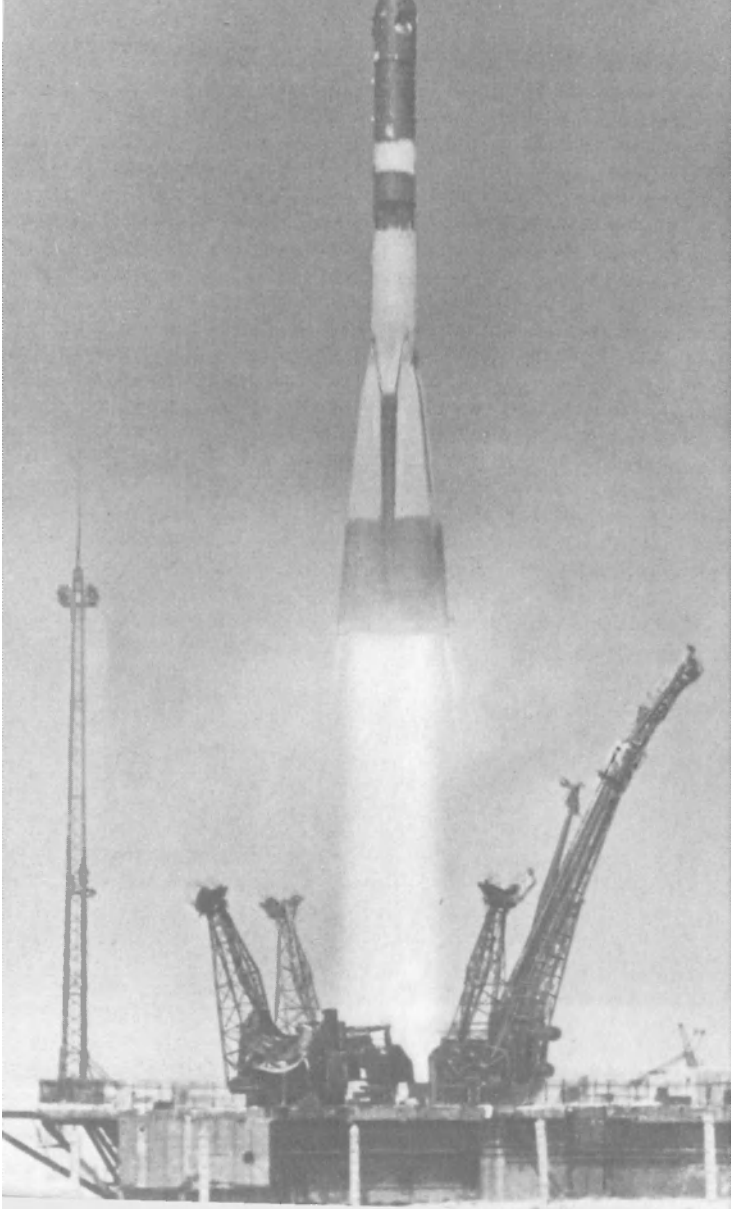
At the site of Gherman Titov's landing, August 1961





Touchdown of the *Vostok* landing capsule

Launch of the *Vostok* booster rocket →



"Rest a bit, Protons. The station is going into a shadow. You can resume work later..."

A special winch helped to straighten out the pleats. A new "sail", 4.6 square metres in area, grew over the station.

The cosmonauts slowly made their way back to the hatch. They took one last look at the stars and the planets and then entered the compartment, testing to make sure it was hermetically sealed. After finally removing their heavy spacesuits, they could at last wipe the sweat from their faces. They had worked in open space for two hours and fifty minutes. Flight Control gave them pleasant news:

"Great work! Congratulations!"

The assembly of a new solar battery panel was not the usual type of experiment. It opened a new direction in manned space flight—the creation of huge orbiting complexes from parts delivered by rockets from earth. These complexes could be new manned orbiting stations capable of providing for hundreds of cosmonauts, or giant solar energy stations supplying the earth with energy by means of laser rays. Such projects will be considered in the not too distant future.

Vladimir Lyakhov and Alexander Alexandrov completed their flight in November 1983. After being in orbit one hundred and fifty days, the crew returned to earth.

The space orbiting station has not only increased the possibilities for conducting research of the earth, space and the universe but has also made it possible to carry out interesting international programmes.

Representatives of the participating countries in the Intercosmos programme and also of France and India have worked aboard the *Salyut-Soyuz* orbiting complex. After returning from his space flight, French cosmonaut Jean-Loup Chretien said: "My

Soviet colleagues have made me an addict of space. I want to go up again."

It should be noted that French scientists have a number of interesting ideas about space. For example, one project envisions launching into the earth's orbit three "sail" satellites that will look like giant kites. The pressure of light will cause these unusual satellites to travel to the moon. The cosmic sails will be made of teflon, a special synthetic material.

Concerning the Soviet-Indian space venture, the following incident is of interest. After making his historic flight, Yuri Gagarin received invitations from the governments of many states. He visited many countries throughout the world, including India. Hundreds of thousands of people of this ancient country turned out to greet him. During a meeting with members of international space and aviation clubs in Calcutta, Gagarin was given a silver globe with a satellite. He observed then: "India will be in space."

The years passed. On April 3, 1984 at 17.09 the *Soyuz T-11* spacecraft was launched from the Soviet Union. Aboard were Soviet cosmonaut-pilots Yuri Malyshev, Gennadi Strekalov and cosmonaut-researcher Rakesh Sharma of the Republic of India. Meanwhile, cosmonauts Leonid Kizim, Vladimir Solovyov and Oleg Atkov, who had been orbiting the earth for months aboard the *Salyut-7-Soyuz T-10* space complex, awaited the crew of the *Soyuz T-11*. On April 4, 1984 the docking occurred.

The work-filled days aboard the orbiting space station began. Various medical experiments were conducted, the condition of the cardiovascular system of the cosmonauts was tested by measuring the bioelectrical activity of the heart and registering the micromovements of the body caused by the heart's activity.

Rakesh Sharma tested the effectiveness of special

yoga exercises in preventing some of the negative effects of weightlessness on the human organism. The results of this experiment are certain to be of great interest to doctors.

In addition to medical experiments, the cosmonauts aboard the orbiting space complex carried out geophysical research. They observed and photographed the Nicobar and Laccadive Islands, the ice cover of the Himalayas and the geological structure of the territory of India.

The week passed quickly, and soon it was time to leave. Leonid Kizim, Vladimir Solovyov and Oleg Atkov remained in space while the Soviet-Indian crew returned to earth. On 11 April the cosmonauts touched down safely.

Once, in answer to a journalist's question, Yuri Gagarin said: "We are often asked why we need such exhausting work, why we work so hard when we know we are wearing ourselves out. But do people facing an important task or a great goal think about themselves, about how much their health is being undermined, about how much strength, energy and effort they can give and not ruin their health? A real patriot, member of the Young Communist League and communist never think about it. The most important thing is to fulfill the mission."

Gagarin's words reveal just how significant the training programme on the ground is for space flight, and how much of a workload and what responsibility the specialists and management of the Cosmonaut Training Centre carry. And it is no coincidence that the work of the cosmonauts and the employees of the Centre have been highly commended by the Communist Party and the Soviet Government. In 1968 the Cosmonaut Training Centre was awarded the name of the pioneer of space travel, Yuri Gagarin.

The Museum

The idea behind establishing a museum in Star City arose when schoolchildren, who had come to visit the training centre asked Yuri Gagarin to show them the museum. Gagarin wondered: "Are they kidding or giving us a hint?" The next day he approached his fellow-communists: "Let's build our own museum. It will offer a unique account of our work, and anyway, we need a museum for history and the younger generation."

Today the museum contains more than eight thousand exhibits. Some are the gifts the cosmonauts received when travelling—presents from workers, farmers, heads of states and governments and public organizations. Here also is a wide collection of photographs, albums, paintings and personal belongings of our space explorers, or objects they took with them into space. Yuri Gagarin's map case is today an important exhibit. There is also a box of coloured pencils that Aleksei Leonov used to draw his surroundings while in space. They are mute witnesses of man's first walk in space. Everything connected with the history of the Cosmonaut Training Centre has been collected here in this museum. All the residents of Star City have become interested in the museum, and new exhibits are acquired almost everyday.

Yuri Gagarin's work study has been moved to the museum, where it is kept just as it was. There is nothing extraneous in the room: everything deals with his work. His well-known handwriting is seen on the desk calendar: "Flight training"; "Flight training planning"; "Information".

Gagarin's whole life was dedicated to his work. Also on the desk is the text of a speech Gagarin had planned to give at a commemorative gathering celeb-

rating the 100th anniversary of the birth of Maxim Gorky. There is also a bust of Tsiolkovsky, a lunar globe and a bookshelf containing the autographed works of famous and little-known writers in all the languages known to man. Hanging in the closet is a grey greatcoat and a cap—obligatory items for all military men. On the wall is a stopped clock—a frozen moment in time. It happened on March 27, 1968. On this day the Motherland lost one of her most glorious and dedicated sons.

Gagarin's name has become a symbol for courage and a measure of heroism. It is known throughout the world. It is a name we first heard on an April day in 1961, and it will live forever. Gagarin accomplished a great deal in his short life, but there was also much he did not live to achieve.

Soon after making his flight, Gagarin addressed a session of the Supreme Soviet of the USSR and said that the Soviet cosmonauts were prepared to explore space with the American astronauts, to develop co-operation for the good of world science and the people. He did not live to hear the news announced on radio and television: "The *Soyuz-Apollo* docking has taken place."

But he had done much to make this event a reality.

The Star City museum contains many exhibits concerning preparations for and the mission of the *Soyuz-Apollo* joint space venture. Here are found not only model spaceships, spacesuits and equipment, but also the pennants and state flags exchanged by the Soviet and American cosmonauts.

The significance of the museum is considerable. It represents the history of the establishment and development of the Soviet space programme and tells about the heroic deeds of the space exploration pioneers. For example, the Star City museum has on

display the life-support system that allowed Aleksei Leonov to make man's first walk in space.

By studying the many displays of spacesuits in the museum, it is possible to track the development of the technological equipment provided for the flights. There are "old-fashioned" spacesuits, such as the one Gagarin wore, and the most modern protective gear, which looks like a little house. The museum's "wardrobe" also contains the lightweight jumpsuits worn by the cosmonauts aboard the *Salyut* station. These have numerous pockets on the sleeves, chest and waist.

But the major function of these work outfits was to prevent the atrophy of muscles and bones, which, in conditions of weightlessness, do not have to work as they do on earth. For example, when Andrian Nikolayev completed his 18-day flight, he compared the feeling in his legs to that of a man whose "legs were turned into a tail". But after spending 63 days in space, Klimuk strode across the steppe without problem. He and Sevastyanov had worn the special work jumpsuits that kept them from "forgetting" the earth's gravity.

The principle behind the jumpsuits is really quite simple. Doctors had asked engineers at the construction bureau to make "weighted clothing". Light weights sewn into the fabric constantly provide a vertical pull on the body. Thus the cosmonaut's muscles that provide vertical stability are in effect continually working, although under conditions of weightlessness there is no need.

Another item of space clothing was designed to help counter the effects of weightlessness—the sports suit, which is worn by the cosmonauts in their orbiting "stadium" where they can walk, run, jump, and lift barbells and hand weights. The only important thing to remember is to fasten yourself secu-

rely to the floor before taking the first step on the moving treadmill. If not, you'll fly up to the ceiling and wind up with a bump on your head. For this reason the cosmonauts' sports suits have special straps for tying the body to the treadmill.

The first cosmonauts were given soft helmets to wear, but they were found to be unnecessary: weightlessness quickly teaches by trial and error, and already by the second day the cosmonauts feel like fish in water—all they have to do to get from one place to another is move their "fins".

Also in the museum are exhibits of the kinds of foods the cosmonauts eat. It had been established right from the very first space flights that weightlessness did not interfere with a person's ability to eat food and drink water. Aboard the *Vostok* and *Voskhod* spacecraft, the cosmonauts were given rations of pureed food in tubes. Later the assortment of food products increased considerably to include "real" food—cutlets, cooked meat, veal, and boneless chicken. To facilitate eating and to prevent crumbs from forming, the food is prepared in bite-size morsels. Each cosmonaut is given 1.6 litres of water per day, the total amount of liquid, including that in the food, is about 2.9 litres.

Just how complicated the eating process is in space was demonstrated by the first American astronauts. Scott Carpenter, for example, went hungry after removing the cellophane wrapping from a sandwich he was trying to eat and watching it turn into crumbs that were impossible to eat under the conditions of weightlessness. Gordon Cooper had a difficult time trying to eat as well. Due to a mechanical failure, he was unable to drink the water from a container specially designed to facilitate drinking in space. And since his food was dehydrated and packed in containers with an attachment for adding

water to make the food edible, Cooper experienced hunger as well as thirst. Though he was in orbit only thirty-four hours, he lost almost three kilogrammes.

The museum has acquired as exhibits a model of the *Vostok* spaceship and training equipment. Now that we have an entire space station consisting of several rooms in orbit it is difficult to praise the cramped space, few instruments and minimum comfort of this first spacecraft. But Soviet scientists put much effort into the design and construction of this prototype. Five satellites, more or less exact copies of the ship that would carry the first man into space, were launched from May 1960 to March 1961 just to further develop systems already designed.

By early April the *Vostok* was completely ready for a manned flight. Weighing 4.73 tonnes, it was composed of two compartments: the landing module and the equipment section. These were connected by four belts held together by a pyrotechnic lock. The landing module, with the cosmonaut's cabin, was made in the form of a sphere 2.3 metres in diameter, weighing 2.4 tonnes and covered with thermal insulating material.

The cabin had three portholes protected by heat resistant glass and also an ejection seat for a cosmonaut dressed in a spacesuit. The seat contained a ventilation system for the spacesuit, parachute systems and an emergency landing kit. The seat also served as a means of rescue should the launch be unsuccessful. Special rocket engines attached to it could eject the cosmonaut from the danger area to a height sufficient for the rescue parachute system to work.

Inside the cabin was the pilot's control panel for operating the ship. With the aid of a miniature globe attached to the instrument panel, the cosmonaut

could track the location of the ship with respect to the earth.

The air conditioning system inside the cabin allowed for maintaining normal pressure and oxygen levels and a temperature of 12-25°C. There were enough food and water supplies and sufficient chemical substances to regenerate the air to last ten days. The *Vostok* had radio equipment to keep the cosmonaut in contact with the earth, a telemetric system for monitoring the condition of the cosmonaut and controlling the functioning of the systems, the condition of the air and control panel instruments, and also a television screen to permit visual viewing of the cosmonauts.

On April 12, 1961, Gagarin's flight justified the choice of design and equipment for the ship. In the future the *Vostok* would serve as a prototype for the construction of more modern spacecraft designed for more complicated missions.

The museum's visitors' book includes some distinguished guests:

The Polish delegation of the United Workers' Party: "We wish the cosmonauts of today and tomorrow new great achievements."

The delegation of the Bulgarian Communist Party: "The colossal achievements of the Soviet Union in the exploration of space demonstrate the great historic role of the CPSU and Soviet Union in the development of human progress."

"Man's highest creative achievement—the conquering of space by Soviet heroes—has evoked the admiration and respect of the creative people—writers, poets, artists and sculptors, composers and actors—who have come here to demonstrate their gratitude to those who have forever brought glory to our country."

And many, many others.

The Endless Roads in Space

We have tried not only to answer the question: "Why should man explore space?", but also to describe the people who were the first to venture into space. Any movement ahead is based on man's quest to gain knowledge.

In April 1968 the world's first cosmonaut, Hero of the Soviet Union Yuri Gagarin was to address a UN conference on the research and utilization of space for peaceful purposes. He had wanted to speak about the new profession of space exploration and the great tasks space research would have to solve in the interests of modern civilization. Killed in a tragic airplane crash, Gagarin was unable to share these thoughts.

The documents and papers of the first cosmonaut reveal his thoughts and emotions. These few yellowed papers are now priceless.

...It is in man's nature to seek the new and the unknown; he has an unquenchable thirst to understand his environment. This is the key to man's continuous and endless progress.

"Expeditions travel to all corners of the globe. Scientists seek, find and seek again, searching for the unknown in order to give it to the people. Restless tribes of pioneers and discoverers walk the desert, plough the oceans, descend to the bottom of the sea and fly beyond the clouds.

"A half-century ago Konstantin Tsiolkovsky wrote: 'Our planet is the cradle of reason, but one cannot live in a cradle forever... Man will not remain on earth forever, he will race after light and space, at first timidly penetrating the atmosphere and then conquering the rest of the solar system.' Today we are witnesses to the realization of those prophetic words.

"The rapid developments in science and technology in the last decades made it possible to lauch an artificial satellite into a circumterrestrial orbit in October 1957. In 1961 man took the first step out of his cradle into the endless expanse of the universe. Four years later he left his spaceship and looked at the earth through the thin glass visor of his space helmet.

"Thus began the space age, the exploration of the universe.

"Today hundreds of complex and ingenious machines circle the earth in their own orbits. They help man study the structure of the earth, predict the weather, navigate ships, maintain wireless communication with the remotest spots on earth and provide many other services. Yet despite the enormous significance of these automated orbiting machines and interplanetary stations, it is man who plays the decisive role.

"Even the most modern machine must be programmed beforehand, while man can alter a programme in accordance with circumstances and observe those slight variations and nuances in his surroundings that a mechanized system would overlook. And it is difficult to overestimate the importance of personal impressions and perceptions. Though they may not always be precise, they are influenced by emotions, which sometimes make them more important than the dry data processed by a machine. As the saying goes: better to have seen something once than to have heard about it ten times.

"Today we can state with confidence that the duel between machine and man has been won by man. The machine is his servant and helper, and in some cases man cannot do without machinery. But man's place in future space flight is assured."

The years have passed and experience has given

credence to Gagarin's ideas about man's new profession and its importance—into space for the sake of the earth, "to extend our knowledge about the universe, to learn new laws and use them for the good of man". "The profession of the cosmonaut must be a peaceful profession and the results of research ... must be used to make life flourish"—this was Gagarin's wish, this is his legacy to mankind, this is the Soviet space exploration programme.

Our planet is small, a grain of sand in comparison with the stars and galaxies. But the people who live on this grain of sand are capable of reason, and their thoughts have travelled far beyond the earth's limits, beyond the invisible barriers of their own galaxy into new galaxies discovered and named by the inhabitants of earth. The years will pass and people will no doubt reach other planets, perhaps other worlds. And the answers to the most important questions concerning the development of the universe—is there life on other planets? is there some unknown process in the universe whereby energy and mass are transformed?—are to be found in space exploration.

Man is great and powerful, and his endeavours are great. We were not searching to set records when we reached for other planets, sent probes to Mars and Venus, orbited the moon, directed the soft landing of lunar modules on its surface, devised a means of guiding back to earth containers filled with lunar rock...

Not too long ago we were dreaming of long-term orbiting stations with rotating crews. And now we are planning the construction of space cities, astropolises with well-developed industry and production and living complexes.

In addition to solar energy, space colonies will use thermonuclear fusion as a source of energy.

Clearly, these "flying cities" will make use of plasma engines which offer an important advantage: the expenditure of fuel is twenty to fifty times less than usual. This has already been proven experimentally.

In short, much work lies ahead.

Time inexorably moves ahead. Just a short while ago the entire world applauded the Soviet Union's launching of the world's first artificial satellite, and now dozens of countries have embarked on space research.

The launch of the artificial satellite over thirty years ago opened a new era in the history of man. It represents the fulfillment of man's bold dreams, the triumph of science and technology. Just as Soviet scientists had predicted, artificial satellites paved the way to the endless universe, opened the road to the planets of the solar system and laid the foundations for organized and extensive scientific research of our galaxy.

On October 4, 1957, the TASS report with the news about the launching of the first artificial satellite disrupted the humdrum, highly organized existence of the cadets at the aviation academy. One of them was Yuri Gagarin. Everyone was excited. That which had just a short while before seemed a distant fantasy, an impossible dream, had become reality. The cadets gave flight to their fancy and began to dream about voyages to the planets of the solar system and wondered who would be the first

cosmonaut. The opinions varied. Later Gagarin would say that he was afraid to admit to himself how strongly he was drawn to space. But that feeling would never leave him; it would strengthen and encourage him.

Writing to his family, Gagarin explained:

"Everyone was overjoyed by the news about the launching of the earth's first artificial satellite. It is a great victory for our country, for all mankind. Now it seems a manned flight is not too distant. I would love to go myself."

Other satellites, interplanetary probes and rockets would all be launched after this first satellite. On 12 April 1961, for the first time in the history of the world, a man flew into space. Soon multi-manned spacecraft were being launched, and space stations with rotating crews were orbiting the earth. Today space exploration is making a contribution to the solution of problems in such spheres as navigation, communications, meteorology, agriculture, geology, astronomy, geophysics, metallurgy, medicine, cartography and many others.

Space exploration has made it possible for man to see the other side of the moon and, in 1969, to set foot on its surface, to reveal many of the secrets of our solar system, discover the earth's radiation belt, gain an understanding of the inexplicable phenomenon of the Northern Lights, and learn more about the mysterious neutrino particles.

Man's voyage into space accelerated scientific and technological progress. Space research has given birth to entirely new fields of modern science and technology and stimulated the development of those already in existence. Space research has given science a number of complicated tasks to fulfil, demanded the quick solution to many scientific and practical problems, and called for new methods of research.

At present it is impossible to evaluate all the prospects man now faces.

A short while ago the most important thing was to learn to live in space. Then we had to learn how to work under conditions of weightlessness. Now, our efforts are directed towards colonizing space, obtaining the maximum benefit for man and for our entire civilization.

The Soviet space programme is extensive, diverse and long-term. It is also consistent and purposeful. The Soviet Union considers space research essential to gaining an understanding of the forces and laws of nature and utilizing them in the interests of all the people on earth.

The Soviet space programme has three clearly defined goals. The first is general research of the near-earth space, the second—work to improve the space technology necessary for research into the near-earth space, outer space and other planets in our solar system; and the third—finding ways to utilize space research for the benefit of the economy and culture.

Soviet scientists believe long-term orbiting stations are essential to deriving benefits from space. One day these stations might become cosmodromes in the sky—launch pads for spaceships travelling to other planets. They will make it possible for us to construct huge orbiting scientific laboratories in order to conduct research in space, and will play an important role in the development of geophysics, astronomy, biology, medicine, meteorology, geography, geology and other important sciences.

Man's flight into space cannot be compared to the discovery of a new continent or ocean. An entire world has been discovered. And one of the most important objectives of the space programme is to conduct scientific and technological research in

space in an effort to create new materials and develop technological processes impossible or impractical to create on earth.

The Soviet space programme creatively and successfully combines numerous interconnected branches of research. It includes both manned space flights and the launching of space probes. Using both man and machine has raised the effectiveness and scope of space research, making it possible to conduct studies in outer space as well as in the entire solar system. Photographs taken from space of the earth's surface, especially the more remote spots, have been of great interest to Soviet scientists and economists. For example, recently a vast territory of the Soviet Union (5.5 million square kilometres) with diverse natural and economic conditions was photographed from space. The importance of these photographs is difficult to overestimate: they reveal in one photograph frame the zones where the greater part of the country's known and potential mineral resources are concentrated and where its most powerful economic complexes are being built and are now functioning and being developed. This information is being widely used in the exploration of oil, gas and minerals.

The space photographs of the Pamir and Tien Shan Mountains and the Caucasus are being used by specialists to help evaluate hydroelectric potential, productive water reserves, seismic conditions and the danger of landslides. Of equal importance are the photographs of pipelines and other large-scale construction projects and their adjacent territories.

The Road to Knowledge

For years now scientists have debated the existence of extraterrestrial civilizations or some form of

life on other planets. Scientific treatises and hypotheses have prompted a spate of science fiction novels seeking to convince earthlings of the existence of life in other galaxies. After the launching of the world's first artificial satellite, interest in this topic flared. Each time a rocket orbits the earth or a probe is sent to a planet in our solar system, new hopes arise. Scientists make "realistic" conjectures and writers describe the inhabitants of other worlds they meet in their imagination.

Legends abound concerning visitors from other planets and spaceship crashes. To try to discover the truth, we turn to scientific and geological sources, to those gifted with ESP, cosmonauts and astronauts.

Remembrances of the Future and *Back to the Stars*, two sensational books by Erich Däniken, helped increase the ranks of UFO believers. Imaginations were stirred and needed new food for thought. Scientific discussions turned into long debates between believers and non-believers.

There were reports in the Western press about the astronauts meeting aliens on the moon and seeing UFOs while orbiting the earth. And from time to time a story is printed about the sighting of a UFO over Mexico.

"Do you believe in flying saucers?" a Mexican journalist asked Frank Borman after he had orbited the moon. The American astronaut replied that he did not and that the existence of UFOs could not be scientifically proven. But Borman went on to say that publishing houses and commercial businesses would like us to believe in them.

Still, the debate about the existence of extraterrestrial life continues.

Harlow Shapley, a West European scientist, maintains that intelligent life in our galaxy exists only on earth. But according to American astronomer Otto

Struve, there are fifty billion planets similar to earth in our galaxy. Some form of life exists on at least two to three billion of them, and intelligent life on several million. It should be noted, however, that this assertion contradicts data which suggest that all stars similar to our sun are binary. Thus the temperature on the surfaces of the planets which might rotate around such stars would fluctuate between extremes. In other words, the majority of planets are not suitable for life.

Here I would like to refer to the authority of Konstantin Tsiolkovsky, who believed in the existence of intelligent life forms on other planets. In answer to a student's letter, the Soviet scientist wrote in 1933: "It is possible that higher intelligent beings have tried to help us because they are continuing to do so. Meditations about the universe could also have served as the basis for belief in higher life forms. But this is not evident to all. People do not try to prove to animals that they are irrational. The distance between people and higher forms is hardly less, if we take into consideration the masses of average people. On the other hand, the Australians and Americans waited thousands of years for the Europeans. *We will not wait in vain either.*"

Many years ago Yakov Perelman, a Soviet popular science writer, wrote that if we are fated to establish direct contact with other planets, bring them into the sphere of our mining industry or perhaps even colonize them, then astronomy will one day be known as "celestial geography and geology".

In his work *Studying Interplanetary Space with Rocketry*, Tsiolkovsky wrote:

"The countless planets, including the earth, are islands in the endless etheric ocean. Man occupies one of them. But can he not use others as well and also the power of the innumerable suns?"

Scientists around the world are now involved in the search for intelligent life in the universe. In December 1981 a symposium devoted to this topic was held in Tallin. More than two hundred scientists from twenty countries presented reports reflecting not only the great interest in this area but also the significant material that has already been collected. In recent years methods of searching and the major directions in this field of research have been mapped out.

Earth is transmitting radio signals deep into space, and scientists have constructed huge antennas and other equipment to try to pick up signals from distant planets. We have not yet received any form of communication from an extraterrestrial civilization. Does this mean that our planet alone is inhabited by intelligent beings?

I believe such a conclusion would be unscientific. Of course I do not wish to call into question the paths and methods used by scientists in their search for other civilizations. But it is our right to ask the question: why should radio signals be considered the only reliable means of information?

Perhaps at our civilization's present level of development radio communication is the most reliable method. But we do not know the level of development of the civilizations we are trying to contact. We do not know at what frequency to search for signals that may have been transmitted by our fellow intelligent beings. We do not know from what direction we should expect to receive a transmission, if indeed there will be one. At the Tallin symposium several viewpoints concerning the possibility of making contact with extraterrestrial civilizations were discussed.

It was noted that though there is as yet no direct proof of the existence of other inhabited worlds, the search for other civilizations should continue.

Most scientists believe the universe was formed 15-20 billion years ago; our solar system—5-7 billion years ago. Scientifically, one cannot speak of the beginning or end of the development of the universe. It is constant and eternal. Our present universe, it is assumed, was formed as a result of a huge explosion.

Try to imagine a gigantic gas and dust cloud dissipating into nebulae whose composition is 98 per cent hydrogen and helium, the rest—solid particles. One of these nebulae is our future solar system. As the nebula contracts in accordance with the laws of stellar mechanics, it becomes more flat, like the central part of a lens. A layer of dust forms, but it is unstable and dissipates into numerous dust clusters. The clusters collide with each other and unite and contract to form bodies several square kilometres in area. These bodies exert gravitational pull on each other which gradually accelerates their flight. The smaller bodies disintegrate upon collision while the larger ones continue to grow until they reach the size of the planets, forming a stable system that will exist for billions of years.

The tremendous energy released by these collisions was transformed into heat. And since large bodies could penetrate hundreds of kilometres inside a planet, that portion of heat released upon impact and unable to reach the surface and radiate into space, instead heated the surrounding rocks. Calculations reveal the upper layers of the planets were formed under high, even partial melting temperatures. The central part of the earth, for example, was initially colder and was only gradually warmed by the radioactive heat and energy released upon the formation of its heavy core.

At first radioactive elements were dispersed more or less evenly throughout the planet. The heat of

small planets was easily radiated into space. But the larger the planet, the more heat was unable to escape. At a certain stage in the formation of the earth, the rock thousands of kilometres from the surface reached melting temperature. Light substances began to rise to the surface while the heavier material sank towards the centre. Eventually a core was formed. Except for its very centre, the core is liquid—most likely molten iron with a mixture of a few other substances at a temperature of five thousand degrees.

Konstantin Tsiolkovsky was convinced of the existence of life on other planets:

"The Milky Way contains hundreds of millions of stars and billions of planets on which life could arise. We have no doubt that it [life] is already there and even in a higher form than that on earth (at any rate, on the majority of planets). Perhaps some of them have powers we cannot even imagine. Such power helped them to propagate developed life, if not on earth then on other planets... There are as many planetary systems as there are suns. Thus each is a cradle of life or a dwelling for intelligent beings. The universe is filled with higher forms of life."

The question of extraterrestrial life directly bears on our actions and psychology. Literature, science and society as a whole must deal with this question.

Much has been written about the riddles and secrets of the earth. No doubt they do exist just as unexplained phenomena of life. In the Arabian desert, for example, structures of stone, "stone cactuses" as they are called, have been discovered. Scientists still have no explanation as to their origin. And in the Pacific Ocean not far from Ogasawara Islands, ships have been known to disappear into a huge whirlpool under mysterious conditions. Scientists have observed that the whirlpool has a radius

of approximately 100 kilometres, a depth of 5 kilometres and 10 times the energy of the usual ocean current. Every 100 days it changes the direction of its movement.

These are but a few of the many strange occurrences that have been observed in the world.

We study space—the moon and the planets—to try to discover how the earth, solar system and the universe itself were formed and developed, how life arose and evolved. The study of the universe is the scientific seeking to understand cosmic laws. But the system of knowledge-seeking itself is also based on science. A successful outcome is more luck than anything else and should not be overestimated: conquering one frontier does not mean victory.

By seeking to understand the universe, studying the laws of stellar mechanics and gaining an understanding of new, often near inexplicable phenomena, man learns about himself as well as his world. The extent of man's potential is as much a secret as the origin of the galaxy.

Reason has no limits. Here I should like to discuss a hypothesis of British astronomers. Recently they discovered a strange solitary star eight light years away from the earth. On studying the star, the scientists determined it was a red supergiant located far beyond any known galaxy. The unusual nature of the object prompted many puzzling questions: how could it have appeared outside a galaxy where there are no conditions for the formation of stars? And if it were formed within the gravitational pull of a galaxy, what forces hurled it out of the star system?

The discovery of the object set off a heated scientific debate. One hypothesis contradicted another. But more and more scientists came to accept the possibility that the object had been created by a

distant and highly developed civilization.

The reality of life exceeds the limitless possibilities of the imagination.

In the early 20th century Konstantin Tsiolkovsky wrote:

"At present, people are weak, still they have changed the surface of the earth. In million years this power will have magnified to such an extent that they will alter the surface of the earth, its oceans, atmosphere, vegetation and themselves. They will control the weather and command the solar system just as they do the earth itself. They will travel beyond the planetary system, reach other stars and use the material of planets, moons and asteroids to build their structures and even create new life forms."

As we can see, the earth and space hold many secrets. But most of them will be studied from space, and they will be provided with scientific explanations.

Where Does the Wind Come From?

Theories about the earth's changing climate are very popular at the moment. There are those who believe the earth is cooling, others maintain a warming trend has set in. As we see, the opinions are diametrically opposed.

We are all accustomed to hearing complaints about the unreliability of weather forecasts. Old people say the forecasts used to be more accurate. And they are right. The increase in technology has made weather forecasting more difficult, not less. Weather information is needed for ship navigation, airplane flights, and to predict natural disasters. But it is also needed for harvesting, providing industry with

raw materials and livestock raising. Yet the accuracy of a twenty-four hour forecast is only 56-61 per cent, and a long-term forecast is correct no more than 30 per cent of the time. Why?

Many scientists believe man plays an irreversible role in making the weather so unpredictable. The "greenhouse effect", which is due to increased levels of carbon dioxide in the earth's atmosphere and the formation of a "screen" that prevents the radiation of heat into space, is cited most often. The temperature of the earth has risen as a result and drastically altered the global temperature pattern.

The concentration of carbon dioxide in the earth's atmosphere has increased significantly in the past 100 years and continues to grow as a result of deforestation, which has led to the direct contact of the humus layer containing carbon-rich organic substances with the air. This in turn has resulted in a rapid process of oxidation. The concentration of carbon dioxide in the atmosphere is also increasing due to the burning of fossil fuels, particularly coal.

If the world's consumption of energy continues at the present rate (especially that of fossil fuels), by the year 2025 the concentration of carbon dioxide in the earth's atmosphere will have doubled, and the average global temperature will, according to many, have increased by 2-3°C. By 2080 there will be a 4-degree rise in temperature which will initiate a mass thaw of the earth's ice cover and subsequent rise in the level of the World Ocean. The warming trend will shift the climatic zones by 300-800 kilometres. Deciduous forests will appear on the shore of the Arctic Ocean and the desert zone will sharply expand.

The US National Oceanic and Atmospheric Administration conducted a study on the effect of industry on the weather and climate and came up with the following mathematical formula: if industry's

emission of heat energy reaches one per cent of solar energy being utilized by natural processes the average global temperature will increase by 1°C. From 1950 to 1982 energy production on earth increased by approximately three times. Predictions are that by the year 2000 the consumption of energy will increase by 10 times. But even that amount is considerably less than the solar energy absorbed by the earth.

American scientists believe the results of "heat pollution" on the climate will not be felt until the end of the century. The first region to be affected will be the east coast of the US, the Great Lakes area, the states of Florida and California and also several regions in Western Europe. In the meantime other equally alarming facts trouble the world.

In October 1982 after a typhoon hit the Philippines, many people were left homeless and much damage was done to agricultural lands. In south-eastern Spain, one hundred thousand people fled their homes in the wake of flooding caused by torrential rains. On the western coast of India a powerful cyclone pulled hundreds of fishing boats out into the open sea, and more than two hundred men disappeared without a trace. A hurricane in Switzerland disrupted highway traffic; forest fires broke out in some areas and resulted in human casualties. A hurricane in the capital city of Madagascar caused street flooding, damage to homes and injuries to people.

In December 1982 many newspapers around the world reported about acid rain and its harmful effects. In the north-eastern regions of the US, in Canada and Northern Europe, acid rain is transforming lakes, rivers and ponds into transparent reservoirs devoid of practically all forms of life—from fish to micro-organisms. Each year acid rain causes millions of dollars in damage to buildings and pipes, and it is

thought to pose a serious health hazard to people.

When it falls over water, this "precipitation" changes the acidity level, over land—it seeps into the soil where it can dissolve natural minerals such as calcium and potassium and carry them into the subsoil, thus depriving trees and plants of a major source of nourishment. This process continues as the moisture moves along the underlying rock and finally makes its way to the nearest reservoir, frequently bringing with it poisonous substances capable of paralyzing or killing all forms of water life.

Almost one-fifth of Sweden's 100,000 lakes have increased levels of acidity. Although some of these are being treated with large quantities of lime to neutralize the acid, from four to nine thousand lakes have already suffered serious biological damage. In the Tovdalselv river region of Norway, 175 of 266 lakes are seriously affected. Ten per cent of the 226 largest freshwater lakes in the US suffer from acid rain. Ichthyologists on the Cape Cod Peninsula of Massachusetts no longer stock eight out of ten of the region's largest fish reservoirs.

A million of dollars is spent each year on neutralizing chemicals. In the past eighty years the amount of acid rain falling over the state of Maine has increased by forty times. A high concentration of mercury, lead and aluminium in contaminated rivers has killed or mutated small salmon. In New York's Adirondack mountains, acid rain has killed the fish and water fauna in approximately 212 lakes and ponds, i.e., six per cent of the total number.

In the FRG, one out of every thirteen trees has suffered some damage. Out of a total forest area of 7.3 million hectares, 562 thousand hectares have only leafless tree trunks standing. Spruce, firs and pines have lost their cones, and the tops of deciduous trees are diseased. In Bavaria alone 160 thousand

hectares of forest have been destroyed, in Baden-Württemberg—130 thousand hectares, and in Lower Saxony—124 thousand hectares.

Natural disasters occur frequently, challenging man's usual concepts about the weather. What does nature have in store for us—thaw or frost? It is hard to be sure. At an international symposium held in the FRG, meteorologists conclude that it will be many years before science is capable of accurately predicting the weather.

Every country in the world observes the weather and tries to follow its patterns. In the USSR alone the economic effect of the use of space meteorology exceeds a billion roubles a year.

Engels wrote that man must only understand himself. He must make himself the criterion for all relations in life, to evaluate them according to his essence, to organize the world in a genuinely human way, in accordance with the requirements of his nature. And then the enigma of our time will be solved by him.

Extraterrestrial Settlements

Just recently it was thought impossible to launch into orbit an entire scientific complex consisting of research equipment, food supplies, water and fuel. But the impossible was accomplished. The *Salyut-6* orbital complex, which was launched on 29 September 1977, was operational for almost five years. The complex made more than 25 thousand orbits around the world and covered a distance of more than one billion kilometres. Experts justifiably claim the *Salyut-6* mission was one of the most remarkable achievements of Soviet and world space research.

Among all the *Salyut* space stations, the *Salyut-6*

was exceptional. Together with the *Soyuz* docking ships, the station was 110 cubic metres in size. This amount of space was enough room for a scientific team to work with a wide assortment of research equipment. Five long-term expeditions worked aboard the complex for periods of 96, 140, 175, 185 and 75 days. Soviet cosmonaut-pilot Valery Ryumin holds the world's record—360 days in space aboard the *Salyut-6*.

Though we have grown accustomed to frequent and significant achievements in space, I would like the reader to know just what is entailed in making these achievements possible.

Life support of the main and 11 visiting crews requires food, oxygen (which is constantly being depleted), scientific instruments, all kinds of interchangeable equipment, film, fuel, etc. According to calculations, several kilogrammes of such necessary materials are needed for each member of the crew each day. While the *Salyut-6* was operational, Progress cargo ships ferried more than 20 tonnes of cargo to the orbital complex. Imagine how much cargo would be needed to provide for a space flight lasting several years, especially considering the trend to increase the size of the crews.

During its time in space the two *Salyut-6* docking devices were used 35 times (docking with 14 *Soyuz* ships, 4 *Soyuz T*, 12 *Progress* cargo ships and the *Kosmos-1267* artificial satellite). The *Soyuz* ships were changed from one docking berth to another four times.

In the scientific laboratory aboard the *Salyut-6* more than 200 technological melting operations were performed as well as hundreds of tests and extensive visual observation and photographing of the earth. In addition, 1,600 astronomical, medical and biological experiments were conducted.

Space experts were successful in rationally organizing living conditions aboard the station, and establishing a precise regime of alternating work and rest periods almost identical to an ordinary work week on earth.

The cosmonauts' diet was given great consideration. The space station's large facilities made it possible to store food products and heat them. A greater variety of foods was made available, and their nutritious content improved.

As I have already mentioned, the space station was technologically equipped for both radio and television reception and transmission. The psychological support television offered the crew members cannot be overestimated. Now they were able to see as well as hear their partners in conversation. Television allowed the cosmonauts to have contact with their families, flight directors, and press correspondents, to watch various entertainment programmes prepared especially for them and be in touch with all the most important events taking place in their country and the world. Though they were far from their country, they never felt cut off.

At some point the communication sessions with the cosmonauts began to be accompanied by background music. The orbital complex increased its own supply of records and video cassettes, and concerts and sports events were transmitted into space. *Progress* cargo ships brought packages from family and friends, newspapers, vegetables and fruits. Above all, the visits of other crews made up of old acquaintances from Star City and the design bureau provided a moral boost to the long-term crew.

Twenty-seven cosmonauts lived for varying periods of time aboard *Salyut-6* (six made two trips), and eight envoys from the socialist community countries visited the station.

On July 29, 1982, the *Salyut-6* orbiting station ceased to operate. Those who created the station won deservedly high praise in both the Soviet and the foreign press. The systems aboard the *Salyut-6* orbital complex functioned much longer than was originally planned.

It was Konstantin Tsiolkovsky who first had the idea for building an orbiting station, and Sergei Pavlovich Korolev who later developed and planned it.

In December 1961 Korolev was quoted in *Pravda* as saying:

"In the future orbital complexes will be designed for long-term use. It will be feasible to send a spaceship to this type of orbital complex which will bring the personnel for control and maintenance and, perhaps, a new replacement crew, as well as equipment, fuel, etc. The docking, and later assembling, of interplanetary ships in orbit under conditions of weightlessness will open up new technological possibilities for improving their design..."

The *Salyut* orbital complex was placed in orbit on April 19, 1971. On June 7, Georgi Dobrovolsky, Vladislav Volkov and Viktor Patsayev began their work aboard the station. This crew was the first to begin the long-term operation of a manned scientific complex, to establish communications between earth and the space station and to create a "space settlement"—Tsiolkovsky's long held dream.

Salyut-7 was placed in orbit on April 19, 1982. It was similar to *Salyut-6* in weight and size, but many of its systems were improved to reflect recent technological achievements and the experience of its predecessor. *Salyut-7* was built after carefully analyzing the operation of the second generation space stations and weighing the almost one thousand suggestions proposed by the cosmonauts who had lived

aboard the orbital complexes.

The docking mechanism aboard *Salyut-7* was improved to handle more massive spacecraft than before. Also, the station's energy supply system was innovated to allow the cosmonauts to increase the power of the solar batteries by adding additional solar panels in space. The spacesuits the cosmonauts wore in open space were also improved (the cosmonauts were now working up to five and a half hours outside the orbital complex).

Many changes were introduced in the life support systems, and living conditions were made more comfortable. For example, the interiors were painted different colours and the decorative panels were redesigned to make them easier to remove to provide access to different systems.

The first crew of cosmonauts aboard *Salyut-7*—Anatoly Berezovoi and Valentin Lebedev—set a new record for space flight—211 days. After landing, V. Lebedev was asked by a correspondent from *Vechernyaya Moskva* if *Salyut-7* had completely fulfilled its mission. The cosmonaut answered:

"Yes, exactly so. It couldn't have been otherwise. The station itself and the spaceship were built with the intelligence and efforts of talented scientists, specialists and workers representing the peoples of all the country's republics."

A. Berezovoi added:

"*Salyut-7* is a very versatile laboratory. We conducted experiments in geophysics, medicine, astrophysics, meteorology, biology and metallurgy. Our flight demonstrated the advantages of *Salyut-7* over its predecessor.

"More systems were automated aboard the new station, making it easier for the crew to control its flight and also to conduct various scientific experiments. Yet another advantage was the equipment we

worked with: in addition to Soviet made instruments, we had devices made in the GDR, Bulgaria, Czechoslovakia and France. This, plus the international crews working aboard *Salyut-7* provide an excellent example of how the efforts of different countries and peoples can be united in peaceful space research."

Valentin Lebedev and Anatoly Berezovoi performed more than thirty geological tests while aboard the *Salyut-7* orbital complex. Specifically, they studied the borders of the Astrakhan Arch—a raised area of the earth's crust. For several years studies of gas reserves had been conducted here, but prospecting was complicated due to a layer of sand on one side of the Volga which blurred the border of the dome. The cosmonauts were able to determine the border of the gas reserve and help make exploration on earth more effective.

The geological structures Lebedev and Berezovoi observed between the Caspian and Aral seas generated much excitement, for they revealed the possibility of new oil and gas reserves in the area.

The second crew aboard *Salyut-7*—Vladimir Lyakhov and Alexander Alexandrov—remained in orbit 150 days and also demonstrated the efficiency of the orbital complex. The third crew, comprised of Leonid Kizim, Vladimir Solovyov and Oleg Atkov, worked in the orbital complex 237 days.

According to specialists, the space programme provides information and services amounting to tens of millions of roubles annually.

In February 1986 a new *Mir* station was launched into orbit. A year later cosmonauts Yuri Romanenko and Alexander Laveikin began their stay aboard the complex. In addition to traditional scientific research, the two men were the first to try out the new Kvant orbiting module. The Kvant was equipped with the unique Roentgen astrophysical laboratory, which

made it possible to study distant stars and galaxies usually hidden from astronomers by the dense layer of the earth's atmosphere.

Many of the instruments aboard the Kvant were designed with international cooperation. For example, the Foswich telescope-spectrometer was made in the FRG, and a special telescope fitted with a tinted filter was designed by scientists in Holland and Great Britain.

On April 5, 1987 the Kvant orbiting module was scheduled to dock with the *Mir* station. At the designated hour the two spacecraft began to approach each other. Flight Control Centre was carefully following their movements. The two craft made contact, but the final docking did not take place. To investigate the cause of the failure, which threatened to abort the entire mission, the cosmonauts left their spacecraft. After several hours of working in open space, they managed to correct the fault, and the Kvant became one of the station's working blocks.

In June 1987, continuing with their mission, Romanenko and Laveikin again left *Mir* to attach additional solar batteries. Their work demonstrated man's preparedness to colonize space.

Cospas-Sarsat

Several years ago the USSR, USA, France and Canada reached an agreement to build a satellite based system (Cospas-Sarsat) to aid emergency rescue ships and planes. The question could be raised as to why these powerful seafaring nations should consider it necessary to enlist the aid of satellites when they have already engaged the services of dozens of specialized fields, including marine navigation, to provide ships with accurate information.

Despite his enormous achievements in science and technology, twentieth century man has not yet rid himself of the many dangers encompassed in this increasingly more complex technology. This includes navigation, where the increase in sea traffic creates numerous dangerous situations. Frequently a captain trying to manoeuvre, in stormy weather and foggy conditions, a huge steel vessel several hundred metres long through narrow straits and canals is unable to react quickly enough to the danger.

Clearly it is impossible to prevent emergency situations from arising on the high seas. Nonetheless, thanks to traffic regulation systems similar to those enforced on highways, from 1970 to 1980 the number of ship collisions in the most dangerous areas of north-western Europe has been halved. In the southern part of the North Sea, the number of collisions has been reduced by four times, despite a significant increase in the sea traffic.

Returning to our statistics we note that during that same ten year period (1970-1980) more than 60 cargo vessels vanished without a trace. Lengthy searches have not revealed, for example, where or why a Norwegian oil tanker sailing under a Liberian flag sank in late 1979 en route from Brazil to Japan.

It is hoped the international Cospas-Sarsat satellite system will prevent such incidents from occurring. The programme provides for equipping each ship or plane with a special emergency radio buoy which can be fed detailed information concerning the coordinates of the ship or plane that has suffered an accident, the nature of the accident, etc. Signals from the buoy are transmitted to the artificial satellites circling over the planet at a height of 800 to 1,000 kilometres. After this information is processed by coastal receiving stations, it is relayed to the ships and planes nearest the accident which take the

appropriate rescue measures.

Both Soviet and American satellites form part of the international search and rescue satellite system for saving lives on land and in the water anywhere in the world. The success of the Cospas-Sarsat system has already been reported in the press. For example, information received by the Soviet satellite Kosmos-1383 helped to determine the coordinates of several air and sea disasters. As a result, Canadian, British and American citizens were rescued from the sites of crashes.

There has long been a need for an international search and rescue satellite system, but it has only just recently been introduced. However, in the short time it has been functioning (and not yet at full capacity), the results have been positive. As the Cospas-Sarsat system becomes fully operational, it will be even more successful in fulfilling its most important mission—that of helping man.

Space, as we see, is being studied, explored and understood. New explorers continue to fly into the universe. But the people will never forget the man who paved the way to space—Yuri Gagarin.

A Man in Space

Virtually every newspaper and magazine in the world has at one time or another published an article about the world's first cosmonaut—Yuri Gagarin. Writers continue to discover new biographical information and little-known facts, and to evaluate his achievement in the light of the 1980s.

In a *Pravda* article entitled "That Unforgettable April", Gennady Sokolov, director of physical training at the Saratov Industrial Teacher-Training College is quoted as saying:

"Gagarin studied here for four years. He was a diligent student and avid athlete.

"The morning of April 12, 1961, I was at a meeting of the City Committee for Physical Culture and Sports. When I returned to the school, the teachers told me: 'Our Gagarin is in space!'

"Soon people began to call from all over the country and from Bulgaria, Yugoslavia, Poland and Hungary. They asked: 'Who is this Gagarin?' And since I knew him well, I could answer without hesitation: 'A great guy.' "

It is difficult to overestimate Gagarin's achievement. Nor is it easy to describe the respect and admiration the people of the world have felt for the world's first cosmonaut since that April day. All the members of this new profession have felt the love of the people, but it was Gagarin who engendered it.

Yuri possessed precisely those qualities needed to be the first man in space. He had all the attributes required to be first among the few. For all of us he will always remain the way we remember him: modest, sensitive, a talented pilot and gifted athlete. He never boasted of his accomplishments and frequently noted that in competing with each other we should not think of ourselves as competitors but as like-minded individuals striving to achieve the same goal. His comrades were certain he would be selected to make the first flight. They also knew that there would be work enough for them as well, that during subsequent flights they would continue and develop what the First had begun. One would make one orbit around the world, another would make several, still another would enter an orbital space complex and another land on Mars. And all would be the first—for space is an endless road.

I did not become a cosmonaut-pilot immediately—I think that would have been too much to hope for.

First I scaled the first height: I learned to fly. Then there was the war with its ferocious air battles. After the victory I scaled the second height and became a test pilot. Fate offered the third; and I was fortunate enough to take it: I became a cosmonaut-pilot. This period of my life could not have become a reality had it not been for my previous training.

I am not one of those rare lucky individuals who determine their own fate by deciding upon a goal early in life and steadfastly and confidently strive to achieve it. I was able to do what anyone who really wants something is able to accomplish. I was able to weigh my aspirations in order to control my actions; I was able to concentrate all my efforts, never searching for the easy way. This is my "talent", and it has served me well.

I don't want to give the impression I was some kind of superman with innate abilities that made it virtually inevitable that I would take part in one of man's most grandiose ventures—space exploration—as some newspapers have commented. I didn't dream of this. This was the dream and achievement of others like Konstantin Tsiolkovsky or Friedrich Tsander, for example. This was their life's work. But for a long time I didn't even know about the work that had already been done in this field. My task in life, as I saw it, was to find my own place among others.

It was for this reason I tried not to fall behind. I always tried to live to the maximum of my abilities, to test myself to the limit. I simply couldn't live any other way. And I don't think life is worth living any other way.

For me and many of my comrades in Star City, the life of Konstantin Tsiolkovsky represented loyalty to a goal. His works, which have been acknowledged around the world, became our work manuals.

He had foresight and dedication, and the ability to think in galactic terms. He was, truly, a gifted scientist.

Tsiolkovsky wrote scientific monographs, political treatises, and fiction. He also wrote instruction manuals for building dirigibles, bicycles and typewriters, and illustrated his own works. But the major theme of his ruminations was space flight. In his own words: "The blue yonder, mysterious skies and example of the birds everywhere in flight have always lured man to lift himself into the air."

Tsiolkovsky was the first to state that the cosmos offered limitless opportunities for exploration, just as the universe itself was limitless. In his works he not only supplied theoretical grounds for space exploration but argued the necessity for it. And he always connected space exploration with the transformation of the earth—its land, seas and atmosphere—for the good of man.

A passionate dreamer, Tsiolkovsky had numerous ideas about asteroids and the planets of the solar system, comets and near galaxies, supernovas and quasars (although these terms were introduced much later). He proposed utilizing the enormous energy of the sun and dreamed of rocket flights, space settlements, and friendship with extraterrestrials, in whose existence he believed his entire life.

Tsiolkovsky dedicated his life to astronomy. He designed spacecraft for interplanetary flight and always remained loyal to his life's principle: serving the people.

"The principal motive of my life", he wrote, "is to do something useful for the people, not to live in vain, to move mankind even the smallest step ahead. This is why I became interested in something that gave me neither bread nor power. But I hope that my works, perhaps soon, perhaps in the distant fu-

ture, will someday give society mountains of bread and limitless power."

Dedicated, purposeful people, burning with the desire to make a contribution of their own to space exploration come to Star City. After passing a difficult recruitment process, future cosmonauts bring to the City the fresh air of their generation, their optimism and inextinguishable faith in their star. And no matter how long and difficult the path to the stars, they never doubt they have chosen the right course. Of this I am certain.

The cosmonaut's profession is interesting and, at first glance, romantic. But our work would be meaningless without dedication and concentrated effort. Space research and the study of the universe continue to make new demands on our profession.

"The cosmonaut," Yuri Gagarin wrote, "is a man whose activities take place under unusual circumstances, which actively influence his organism, often bringing him to the limit of his endurance." Continuing this thought, Gagarin added: "...for now space flight, unfortunately, is the life work of only a few. Therefore these few must know and be capable of much, in order to combine in their person both the operator of a complex machine and the scientist who conducts a large number of the most diverse scientific experiments and observations."

If a cosmonaut even for a moment loses the feeling of being a discoverer, if he succumbs to the illusion that it is like any other job on earth, he could be making his life very difficult without even realizing it. Yuri Gagarin was right: every cosmonaut in space is the first! After all, every flight mission is different from the previous one.

Space remains a mystery for man. There are great fluctuations in temperature, an absence of air, cosmic rays and meteors and other celestial bodies speeding

by. As for weightlessness, it remains a serious health hazard for man.

The spaceship is a tiny particle of our planet. Flying above the earth, the cosmonauts feel like they participate in the many events occurring there. Looking at the earth from space, admiring its sunrises and sunsets, the cosmonaut sees the planet as a single whole and thinks about the endless possibilities of the human mind to explore the universe.

The earth is an incredibly beautiful planet, but compared to the constellations and entire galaxies, it is but a grain of sand. Man, who lives on this grain of sand, is capable of thought, and his thought has already transcended far beyond the boundaries of his native earth, of his galaxy. Man is great and omnipotent, and his deeds are tremendous. It was not for the sake of setting records that he reached the moon, sent probes to Mars and Venus and brought back samples of lunar rock. He explores the universe so that the knowledge he acquires in the vast ocean of stars can be used to help the people on earth.

The small human habitat is not as immense, not as eternal and secure as it once seemed. This is particularly clear from space. The mysterious secrets of nature that have been discovered by scientists have given man incredible powers to strengthen world civilization and transform the earth itself.

Thought and reason know no bounds, if only they do not destroy themselves. And this could happen only if man does not take a definite stand against those who nurture plans for a nuclear war.

Cosmonauts have one unquenchable desire: to fly more often. Even now we cannot complain of lengthy rest periods, and in the near future someone will always be working in space. This will be in the interests of science and space research. Man will conduct impressive experiments in his study of the

universe and the surrounding world, he will discover the laws of space that influence life on our planet. One day he will understand how the solar system originated: how and when our system of planets was formed around the sun, how this system evolved and how it will continue to do so in the future. Most important, he will learn, using Venus and Mars as examples, how to better understand the structure and evolution of Earth. The study of the planets in the solar system with the aid of rockets and space technology has already made it possible to understand those stages in the earth's history which were erased or buried by time.

Much new information about the most distant and mysterious points in the universe and about the enormous cataclysms that occur there has been obtained with the aid of the telescopes located in orbital space complexes. It is hoped that such astronomical observations will help reveal the age of the universe, the cosmologic picture of the world and the type of substances that comprised the young universe.

Science is standing on the threshold of new discoveries and a more profound understanding of the secrets of space. But the neutrino retains its mystery. Neutrinos can be "invisible". These particles have no rest mass and travel freely throughout the universe. (Some Soviet scientists have suggested the neutrinos do possess rest mass.) It is not an easy matter to catch these particles. Recently a new method was used to determine the flow of solar neutrinos, which have travelled to earth throughout the geological ages. The concentration of different radioactive isotopes of the element technetium, which are found in molybdenum ore, was measured.

American scientists have established that the brightest star in our galaxy, Eta Carinae (100 times brighter than our sun) may soon explode and become

a supernova. Astronomers believe that the star has expended its primary hydrogen "fuel" and thus opened a path for the vast amounts of nitrogen formed in millions of years of thermonuclear reactions in the core of the giant star to make its way to the surface.

Since Eta Carinae is located nine thousand light years away from our solar system, it is possible that the star no longer exists, that humans are only seeing its light "portrait" sent thousands of years ago. Eta Carinae is a star in the southern hemisphere so it cannot be observed from the northern latitudes. It is not as bright as Venus, but at times it can be seen even during the day.

The scientific-technical industry in the space field enables us to determine the history of planets and predict their future. Some day it may be possible to alter the climatic conditions of Venus and Mars, to establish settlements on the moon and in open space, and to use asteroids for scientific purposes.

The study of comets is continuing. In the 1980s the comet Austin approached the earth. This is a rare visitor of our solar system. At any rate, until now nothing was known about it. The comet is interesting for its size: it is almost twice as large as ordinary comets. The problem was that Austin was to approach the earth from the southern hemisphere, making it impossible to observe from Soviet territory. This was why Soviet and French scientists asked A. Berezovoi and V. Lebedev to photograph the celestial wanderer. The pictures the cosmonauts took were sent to both French and Soviet scientific organizations.

The international Venus-Halley's Comet project undertaken in 1985-1986 contributed a great deal to comet research. Two Soviet interplanetary space probes, *Vega-1* and *Vega-2*, were equipped with

scientific instruments from different countries and transmitted to earth two hundred pictures of Halley's comet as well as additional valuable information about the traveller.

Scientists believe that some time in the near future man will gain even more knowledge about the moon and planets and interplanetary space. And he still dreams of making a voyage to the distant planets, of landing on Mars, seeing the rings of Saturn at close range, and discovering the secrets of Jupiter. For myself I'd like to add: finding intelligent life somewhere in the vast universe. It is out there somewhere...

Space research is called upon to help in the study of our world. The earth's oceans must be more carefully and systematically studied, for they determine the face of our biosphere. The enormous amount of water on the earth's surface forms the climate and serves as the source of atmospheric precipitation. Half the supply of oxygen in the atmosphere comes from the ocean, which regulates the amount of atmospheric carbon dioxide by absorbing any excess.

The ocean has played a valuable role in the development of our civilization. Almost one-third of the world's oil is obtained from ocean oil rigs. By the beginning of the 21st century, "sea" oil may comprise one-half the oil supply. More and more gas is being extracted from the ocean shelf as well. Enormous deposits of energy essentially untouched by man are to be found in the ocean: tidal energy, sea currents and waves, temperature fluctuations between surface waters and the sea depths, thermal water energy, and finally, deposits of deuterium which man will need when he learns to control thermonuclear processes.

The southern seas are of particular interest to scientists. This is the area of the world that holds

the most hope for providing man with an inexhaustible source of food. The ocean's greatest treasure is krill which is rich in protein. There are hundreds of millions of tonnes of it.

The continent of Antarctica will be studied increasingly in the future. The research being conducted there today, which was encouraged by the International Geophysical Year, has become more systematic. Already 26 Soviet expeditions have travelled to the continent, and seven Soviet scientific stations are now operating there. A wealth of geophysical information has been acquired, specifically, about the properties of the magnetic pole and the ionosphere in the polar region and about the Northern Lights phenomenon. Glaciologists have learned a great deal about the continent's ice cover, and work conducted by geologists shows promising results.

Antarctica is a huge "reserve" of frozen fresh water. The continent's ice cover contains 90 per cent of the world's fresh water. Many scientists have thought about how this frozen water can be used to serve man. It has been suggested, for example, that icebergs be towed to the shores of countries with a dry climate. For the time being though, the cost of such a project is prohibitive.

The study of the Antarctic ice is helping to shed light on the past climate and to predict future climatic changes. Certain difficult questions remain to be answered: why do continents shift, mountains grow, lands sink into the ocean and volcanoes erupt? Will there be a cooling of the earth's climate? Will the earth's position in the galaxy move?

A Woman in Space

In August 1982 Svetlana Savitskaya flew into orbit as a member of the *Soyuz T-7* crew. She was the

second woman, after Valentina Tereshkova, in space.

After the flight was completed, a TASS report noted: "Medical-biological research was an important part of the crew's work and resulted in a great deal of new scientific information. No significant differences between the reactions of female and male organisms to space flight were observed. The successful completion of the mission by the crew, which included for the first time a woman cosmonaut, represents a new and bright page in the Soviet space programme. The scientific data acquired during the flight will be used in different fields of science and the economy and also for the further development of manned space flight."

Svetlana Savitskaya's flight provoked great interest abroad. Western information agencies noted that the Soviet Union had for the second time in the history of space research sent a woman into space.

Space flight is incredibly difficult, and any haste or frivolous race for leadership could have unforeseen consequences. The Soviet Union was able to include a woman as a member of a cosmonaut crew only after installing a reliable life support system aboard the orbital complex. And it was no coincidence that Svetlana Savitskaya was chosen to make the difficult flight aboard the *Soyuz T-7*.

Svetlana Yevgenyevna was the second test pilot to be launched into space. Since I am a test pilot myself, I can understand her character: strong-willed, dedicated, ready to take a risk for the sake of a noble goal, sincere and generous, and the desire to be constantly engaged in creative work.

Svetlana Savitskaya had made more than 500 parachute jumps and flown almost 1600 hours in every type of aircraft, the majority of them jets. She holds 18 world records for flying and parachuting.

Despite the difficulties of the technology and the

enormous physical work-loads, women have found a place in aviation and now space flight. The names of Russian women admired by their contemporaries for their daring and courage remain a part of the history of Russian and Soviet aviation.

Lyubov Galanchikova was one of the first women pilots in Russian aviation history. In 1911 she graduated from the First Russian Air Navigation Association, and her first public flights brought her fame and recognition. Forsaking a career as an opera singer, Lyubov Galanchikova demonstrated her ability as an aviator and made exhibition flights in many Russian cities. In 1912 she set new records flying in some cities in Germany in a new type of airplane construction—the monoplane. Then she flew from Berlin to Paris.

After returning to Russia, Lyubov Galanchikova test flew Russian-made planes and prepared to make a round trip flight from Petersburg to Moscow. She demonstrated her flying ability in America, Switzerland and France, and dreamed of opening a pilot school for women in Russian cities. She also wanted to begin carrying passengers in planes. But her plans were not destined to be fulfilled. During the First World War she and her husband travelled to Paris, from which she was not fated to return.

Lidiya Zvereva was a contemporary of Lyubov Galanchikova. After marrying an aviator by the name of Slyusarenko (a participant in the first flight from Petersburg to Moscow), she herself became interested in aviation. She graduated from the Shchetinin Aviation School and acquired her pilot's licence. Lidiya Zvereva was one of the most daring pilots of her time. She organized exhibition flights in Petersburg, Riga and Moscow, and encouraged women to enroll in aviation schools, directed by the famous Russian pilots Yefimov, Utochkin, Yevsyukov and others.

Courageous women aviators left their mark on the years of the civil war and first five-year plan periods. They daringly tested new technology and set world records in the process.

In 1937 E. Mednikova set a world record in altitude; Valentina Grizodubova, Polina Osipenko, and Marina Raskova set records in flight distance and broke other national and world records. Other women pilots became famous as well.

Women pilots fought heroically during the Great Patriotic War of 1941-1945. The story of Yekaterina Zelenko must be told. After first starting to fly in the 1930s, she received the order of the Red Banner for her service in the Soviet-Finnish war of 1939-1940. From the first day of the war against Nazi Germany she flew combat missions, conducted bombing raids and reconnaissance flights, carried troops into the enemy rear, and had a successful air ram-attack to her credit. She was killed on 12 September 1941 after running out of ammunition.

Olga Yamshchikova was another famous war pilot. She made 217 flying missions during the war and received numerous military decorations. As a test pilot in 1947 she was the first woman to test fly a jet fighter. Today a number of women fly jet planes. But at that time, it was a remarkable feat.

Svetlana Savitskaya quickly captured the attention of the press. She has been written about in Soviet and foreign newspapers and magazines, and radio and television correspondents have interviewed her. Still, she never changed, remaining the same modest, composed and punctual woman her trainers and instructors had always known her to be.

In November 1977 a Moscow paper wrote:

"There are people about whom many nice words are spoken in advance. It is difficult for them because this advance must be earned. And when fame ac-

companies an individual from the very start, more is expected from him. It's not just that he must—he is obliged to justify these hopes. This is even more difficult—to continue to be self-demanding, to be able to see oneself objectively, not to succumb to praise, to do one's work. Savitskaya understood: experience and skill exist side by side with danger—you can acquire expertise but lose your soul. And so she described her victory in the skies over Hullavington in her own modest way: 'I won because I flew calmly. Any of the young women in our team could have won.' " (Hullavington is the name of the British air base where the 6th aerobatics world championship was held.—*G.B.*)

The *Soyuz T-7* mission was exceptional due to the presence of Svetlana Savitskaya. Nineteen years after Valentina Tereshkova's flight, a woman was once again in space. While Tereshkova's flight answered the fundamental question as to whether the female organism could endure space flight conditions, Savitskaya conducted a series of difficult but promising experiments.

Perhaps the work was not sensational, and journalists did not write much about it. But let's take a look into the not so distant future. After all, man will not just orbit around the earth for long. Ahead lie flights to other planets of the solar system. And it is more than likely that the crew on, for example, a trip to Mars, will include members of the fair sex. The men and women who will be leaving their native planet for several years will bring the warmth of earth relationships to different worlds.

To make this a reality we will need not only to solve many complicated technical problems but also to understand how conditions in space influence the female organism. And it would be no exaggeration to say that Svetlana Savitskaya furthered space research

in her work aboard the orbital space complex.

The atmosphere aboard *Salyut-7* changed considerably when Svetlana arrived. The effect of a woman's presence and Sveta's friendly nature made the occasion festive.

Savitskaya and her colleagues conducted more than 20 experiments, including medical research and astronomical and geophysical surveys. Savitskaya also observed the body's reaction to space flight. Physiologists had little data to work with before, so her work in this area was very important.

On September 13, 1982, at a reception in the Kremlin where the crew of *Soyuz T-7* was presented with the highest government awards, it was observed:

"Flight experience is being accumulated, and spacecraft are being improved and even made more comfortable. Still, each step upward is unique. Each step requires knowledge, courage, and more, daring. These are the qualities belonging to the winged daughter of our Motherland, Savitskaya, her space knights, comrades Popov and Serebrov, and the cordial hosts of *Salyut-7*, comrades Berezovoi and Lebedev."

Crossing the Rubicon

All illnesses are bad, but there is one sickness that defies classification. When we experience it, we say, "my soul aches". The individual who suffers a great blow, is bereaved of a loved one or loses his dreams, feels this way.

My soul ached. I suffered from an inferiority complex and a loss of strength and confidence. When my soul had reached the depths of confusion, I gave myself over to meditation. But I still continued to fly.

The test flights were rigorously scheduled; I flew one plane after another. The tension a test pilot lives with is only exceeded by long ground training sessions, the study of blueprints and efforts to gain an engineer's knowledge of new types of aircraft. I had my share of success: I conducted many state control experiments, flew sixty types of aircraft and received all the titles possible for my position: Hero of the Soviet Union, Merited Test Pilot of the USSR, etc. I had a settled family life, all my needs were taken care of. Still, I dreamed of space flight: I dreamed of it and feared it, yearned for it and hesitated. I was uncertain of myself due to my age, already determined flying skills and the psychological difficulty of adopting a new profession.

For the members of the first detachment of cosmonauts the future was completely unknown. They were cosmonaut trainees but had only a vague understanding of their future profession.

I, on the other hand, knew a great deal and could imagine the responsibility the job entailed and even visualize the flight programme. But my predictions would turn out to be incorrect.

I couldn't help but think about my new vocation, about my future life. I was leaving everything I knew and had learned about test flying planes throughout the years, and going to where I would have to begin all over.

Some people believe only the young have romantic dreams, that only youths are daring and bold. I was by no means a youth, but I had a dream about space, and this inspiration gave me strength and that inexhaustible store of energy that cannot be measured in amount or length of duration.

By this time the Cosmonaut Training Centre in Star City was already operating in accordance with established traditions and moral norms. I would

have to accept and acknowledge these rules. The people at the Centre had their own views and customs, their own way of doing things. I was going there to work, to study and to fly. The first people I met were the cosmonauts.

Yuri Gagarin and I did not form a close relationship. Like many of my friends, he did not approve of my decision. While he didn't say so directly, he also failed to give me any outright encouragement. He was outwardly composed, dignified, even a little stiff.

We trained together, flew to the cosmodrome, received guests and played volleyball, hockey and football. Despite the difference in our ages (I was thirteen years his senior), I didn't ask for any special treatment during those games. We were all on a par.

In November 1963 Gagarin was made a colonel. Remarkably, he had gone from a senior lieutenant to a colonel in two and a half years. I congratulated him, knowing how important military rank was to a career officer. Gagarin seemed somewhat embarrassed when he shook my hand. He said something about the war, recalling that then one wasn't promoted for nothing. Recovering from his embarrassment he said: "Your rank, Georgi Timofeyevich, is more meaningful than mine."

Now I was the one to feel uncomfortable. After all, there was nothing wrong with promoting the world's first cosmonaut. His new rank, in my opinion, was a reflection not only of his service and his personal contribution to science, but also made it easier for him to carry out his numerous social and political duties by putting him on a more equal footing with the many leaders of states and governments with whom he met.

It was at this time that Nikolai Kamanin, head of the Cosmonaut Training Centre and an ardent ad-

mirer of Gagarin, wrote in his diary: "In two and a half years Yuri has been promoted from a senior lieutenant to a colonel, something that usually takes 15-20 years. Two and a half years of unparalleled fame have not spoiled Gagarin. He has grown much in this time, acquired great experience in addressing audiences. He can conduct the most difficult press conferences and meetings with great skill. Having travelled to more than thirty countries and participating in thousands of meetings, he didn't have much time to read, to think or study. But the trips and meetings with the peoples of different countries have given him an education that even the best of universities cannot offer."

At first I had difficulty getting along with other members of the detachment as well. There were certain problems and arguments, and some mistakes were made. The members of the news media knew I was there, but, quite honestly, they didn't exactly pay me a lot of attention or compliments.

Our life was one long training session: mornings, evenings, days, weeks and even months long. Experience and knowledge were gained, training methods improved. Consequently, the professional skill of the cosmonauts themselves increased.

Gagarin was seriously training for his second flight. After becoming the deputy director of the Cosmonaut Training Centre, he was daily involved in organizing scientific research and flying exercises. It was at this time that his talent as an organizer and director was revealed.

Gherman Titov continued to test aircraft. He unexpectedly proved to be a real "aviation tiger". His test flights were highly evaluated not only by his superiors but his colleagues as well. As his authority grew, the aviation designers began to carefully heed his professional suggestions. He was a good friend of

many of the designers, was familiar with their work and admired their creative fervour.

Andrian Nikolayev dedicated himself to training for a lengthy orbiting mission. Sometimes this staid and determined man would talk about his dream of flying to other planets. He was not alone. Many of his comrades had the same dream.

For Pavel Popovich, science played the most important role in his future work. He eagerly helped the scientists by compiling and analyzing data and making comparative charts. Soon the scientists grew to respect his opinion. Everything came easy to him. He flew well, quickly gained an understanding of machinery and instruments, easily transferred from one programme to another and never regretted the wasted time and effort spent on a mission he did not take part in. He was the first to begin to write articles and then books.

Valery Bykovsky was a man of few words and deliberate actions, but he was willing to participate in any experiment. For the sake of science, he was prepared, as he put it, to let the physicians "take him apart". Before joining the cosmonaut unit, Valery served in the Moscow Air Defence region. He remained friends with the men he had served with, frequently inviting them to his home in Star City. In a way he envied them: they were able to fly all the time.

Valentina Tereshkova was generous in sharing her knowledge with other women training for space flight. She spent all her time with the women's cosmonaut unit. Nikolai Kamanin advised her to dedicate herself to public duties entirely, but she refused, firmly believing she could do more good working with the cosmonaut trainees.

Valentina was so dedicated to her work that she declined to take her annual vacation or travel abroad

for fear of missing a lesson or training session. We all admired such tenacity.

In 1966-1967 we worked very hard in preparing for the manned flight aboard the *Soyuz.* The craft had been finished before Sergei Korolev's death, but it still had to be tested in unmanned flight. Other space probes and orbital stations were being developed at the same time. In February 1967 the decision was reached to launch a cosmonaut aboard the *Soyuz* no later than April. All participants in the flight were named.

At the end of March, the cosmonauts training for the *Soyuz* missions took their exams. The examining commission, comprised of leading specialists and engineers, was rather strict in its evaluation of the cosmonauts' abilities. But all the men demonstrated their excellent knowledge and were given the "go-ahead" for the missions.

On April 6, the cosmonauts flew to Baikonur. Kamanin permitted those of us not involved in the *Soyuz* programme to fly with them. That evening the engineers met the cosmonauts at their hotel to talk in a relaxed atmosphere about future flights and life in general. We indulged in our fantasies and spoke of the moon, Mars and Venus. It was unanimously agreed that in twenty to thirty years a city would be built on the moon.

At Baikonur, work was going on at a frenetic pace—twenty-four hours a day. The cosmonauts were learning the details of the flight programme, studying the component charts, rehearsing emergency situations, consulting with the specialists, and writing down in their logs emergency procedures.

On April 24 at 3.00, Vladimir Komarov arrived at the launch site. Kamanin walked with him to the lift and said a few words in farewell. Gagarin rode up

with him to the rocket hatch, and at the designated time, the ship lifted off.

As usual, Gagarin stayed in the bunker and maintained contact with Vladimir. He kept the cosmonaut informed of the parameters of the orbit and data about tracking stations. We were all happy to hear Vladimir announce: "Everything is in order." A moment later he added: "I feel great; the flight is proceeding normally."

Komarov was well-liked among the cosmonauts. Both the specialists and his comrades respected his scientific knowledge, and his opinion was always considered carefully. We rejoiced in his success and wished him a safe trip home.

During the ship's final orbit, Komarov repeated the landing instructions he had received and informed Flight Control that they had been carried out. He transmitted all the flight details; everything was proceeding according to plan.

Kamanin gave the order for the search plane to fly to the landing target. While aboard the Il-18, Nikolai Petrovich was informed that the *Soyuz* spacecraft had been sighted 65 kilometres east of Orsk.

At Gagarin's request, all the cosmonauts flew to the area to greet Vladimir. But the meeting was not what was anticipated.

The lines of the spacecraft's main parachute had become entangled, and the ship crashed to earth at great speed. The search team opened the hatch and removed Komarov's body.

Yuri Gagarin and all the cosmonauts were stunned by the first cosmonaut fatality in the USSR. On April 26, 1967 the country bid a last farewell to an intrepid explorer of the universe, our friend Vladimir Komarov.

At a memorial held in Red Square, Yuri Gagarin spoke on behalf of the cosmonauts. A few days later,

Kamanin, who looked aged by the tragedy, called us all together and laid out the future flight programme. He told Gagarin straight out that there was practically no chance he would be allowed to fly again. Kamanin himself would recommend that Gagarin not be permitted to participate in any other flights. Yuri listened to this terrible pronouncement in silence.

Some of the cosmonauts expressed their wish to fly the *Soyuz* and demonstrate its reliability and great potential. Kamanin thanked the men for their noble enthusiasm. He dismissed them but asked me to remain.

"I want you to be the next," he said, looking me in the eye. "This is not the whim or fancy of any one official, it's ... well, you understand. You'll have a competitor—Feoktistov. He's asking to be allowed to test the spacecraft and has written a letter stating his arguments.

"The design bureau is completing new work on the ship. There will be a number of tests and technical launches, which will probably take several months."

I began an intensive training programme. Not once, before or after my flight, I was asked how Komarov's death affected my training and state of mind. Superficially, there was, of course, a connection. After all, I would be flying the same spacecraft in which Komarov was killed. But I didn't make the connection inwardly. Of course I often thought of what a wonderful person Volodya had been, but what I felt was pain and human grief, not apprehension about my own welfare.

It should be mentioned that there was much speculation at that time about the tragedy that had occurred at Cape Kennedy three months earlier: during a ground test of the Apollo capsule three American astronauts—Virgil Grissom, Edward White and Roger

Chaffee—were killed in a flash fire.

It isn't surprising that quite a few people believed this superficial analogy was sufficient reason for making pessimistic conclusions and predictions. But such views, I repeat, reflected only the outward, formal side. Most of the people who directly participated in the space programme saw things as they really were, not in gloomy colours. We knew our technology and believed in it.

Perhaps "believe" is not the appropriate word; we had confidence in it. Of course there can never be a one hundred per cent guarantee of success when testing new technology: risk is an inevitable factor in the experimenter's profession. Regardless of how many tests are conducted and how carefully preparations are made, there is always a chance that something might go wrong or that an entire sequence of unpropitious events might occur. It is impossible to foresee everything.

The man who has chosen to be an experimenter prepares himself beforehand for the risks and emergencies involved. Preparedness is based not only on personal courage but, more important, on confidence in the technology with which one works. Courage means being prepared to take risks, but it does not free one from the feeling of alarm that accompanies those risks. It is only a deep knowledge of the technology itself together with the confidence this inspires that eases the alarm by stripping away unjustified fears. Thus, the individual becomes morally and consciously prepared for the risk. If one lacks faith in the technology, courage will not help; without believing in success it is difficult to achieve it, to perform to the best of one's ability.

In October 1968 it was my turn to go up in the *Soyuz*.

A Great Loss

It seemed impossible: Yuri Gagarin was dead. We would never again hear his voice, see his face or clasp his hand. Few people knew of his death; it was our tragedy, but our grief was so great we could scarcely conceal it.

Star City was immersed in blackness. No light shone in apartment windows, no people bustled down the streets, no cars sped down the roads. The silence was terrible and oppressive. It was hard to breathe and difficult to see.

Only yesterday we were speaking of plans for the future, confidently thinking about new launches, high orbits and the "dusty paths of distant planets" as a popular song went.

...I wanted to think, to concentrate, but my thoughts were coming too rapidly, like the phrases in a telegram. And my memories were sporadic and unconnected...

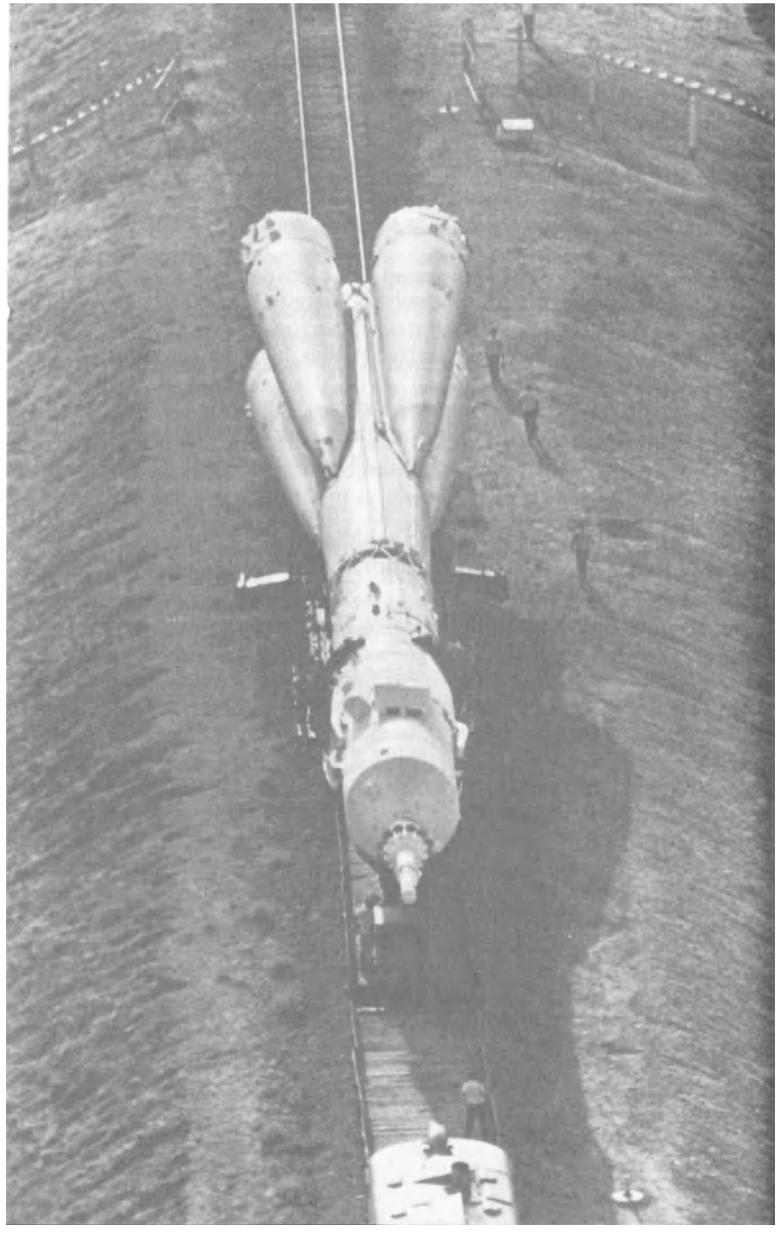
We gathered in gloom and stood silently outside the door to Gagarin's office. The head of the Cosmonaut Training Centre, Major-General Nikolai Kuznetsov, walked by quickly, his eyes downcast. He stopped at the door, turned and said:

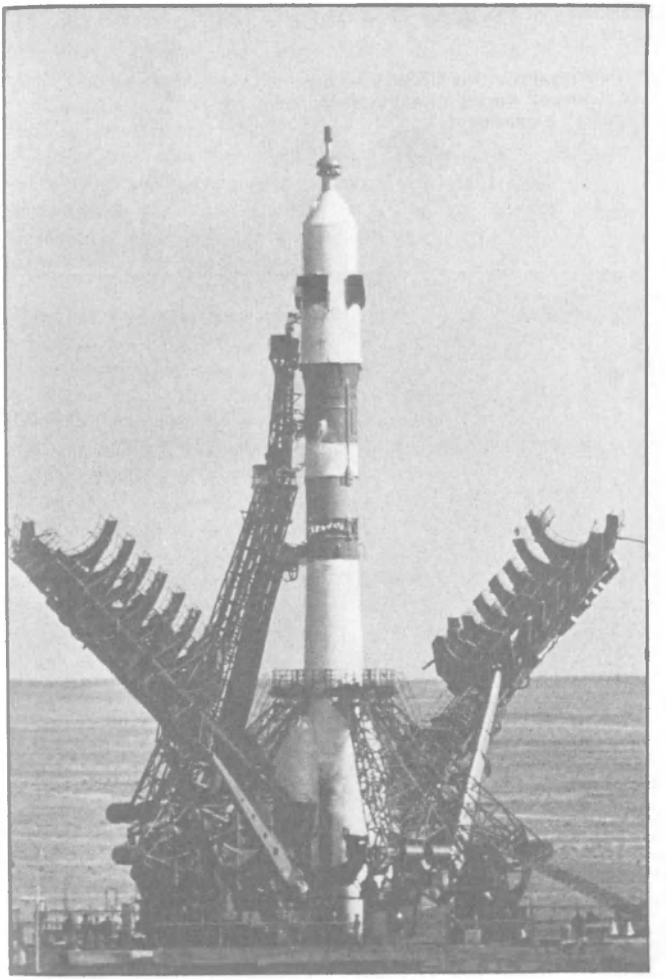
"Don't just stand around together. Go to your places. You might be needed..."

Nikolai Fyodorovich left without seeing to it that his command was carried out. And anyway it wasn't an order.

We were waiting for Nikolai Kamanin.

We already knew that, though Gagarin and Seregin's plane was missing, the search planes and helicopters sent to the area had not found any trace of the crash. This news raced around the offices, laboratories and training facilities. Our hopes were raised: they were alive.



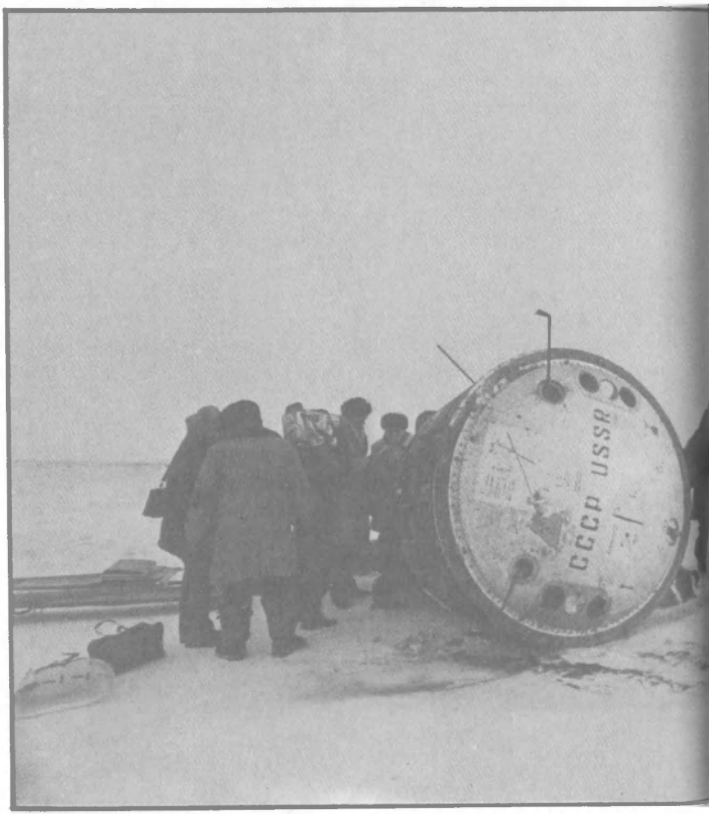


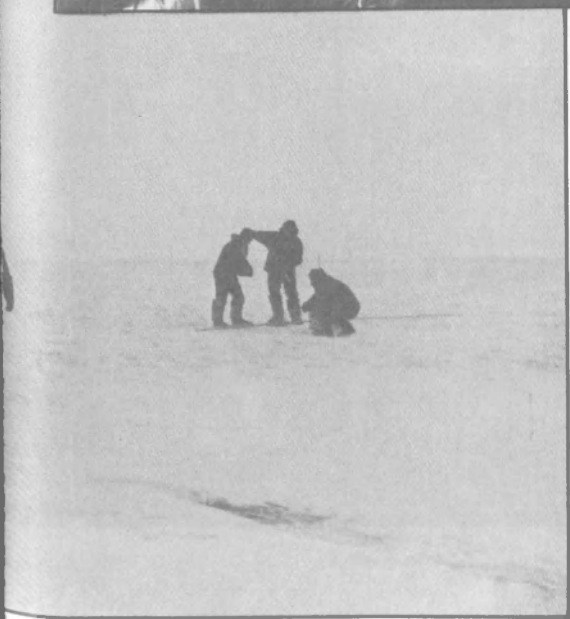
Bringing the *Soyuz* booster rocket to the launch pad

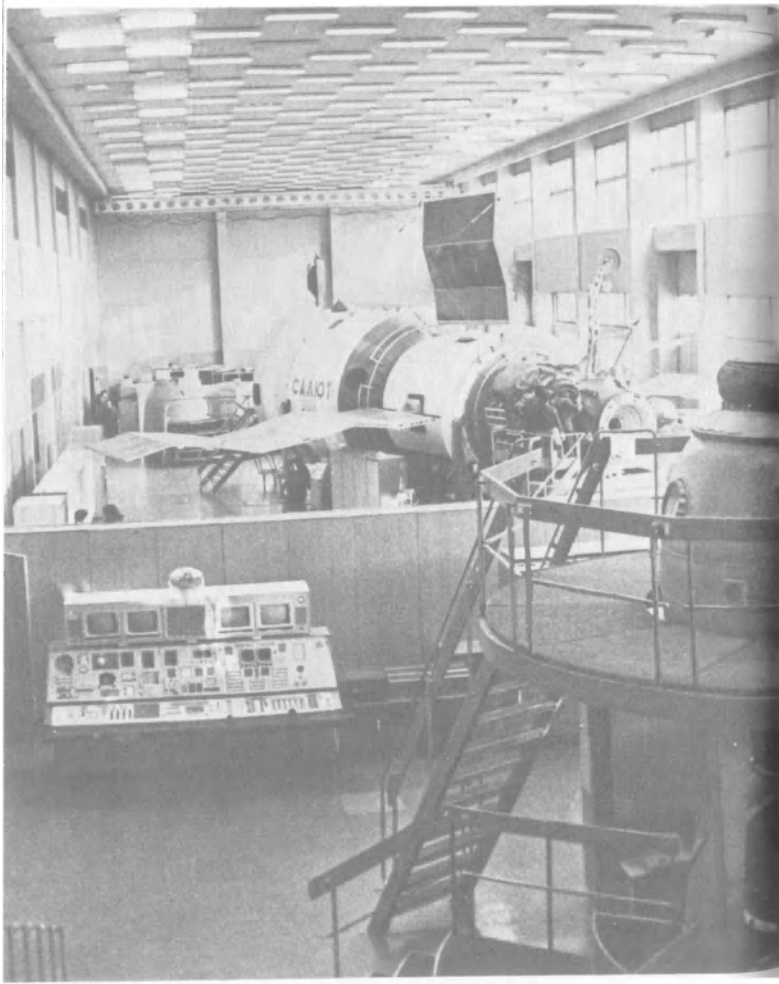
Mounting the *Soyuz-2* booster rocket on the launch pad

Touchdown of the *Soyuz TM-3* landing capsule

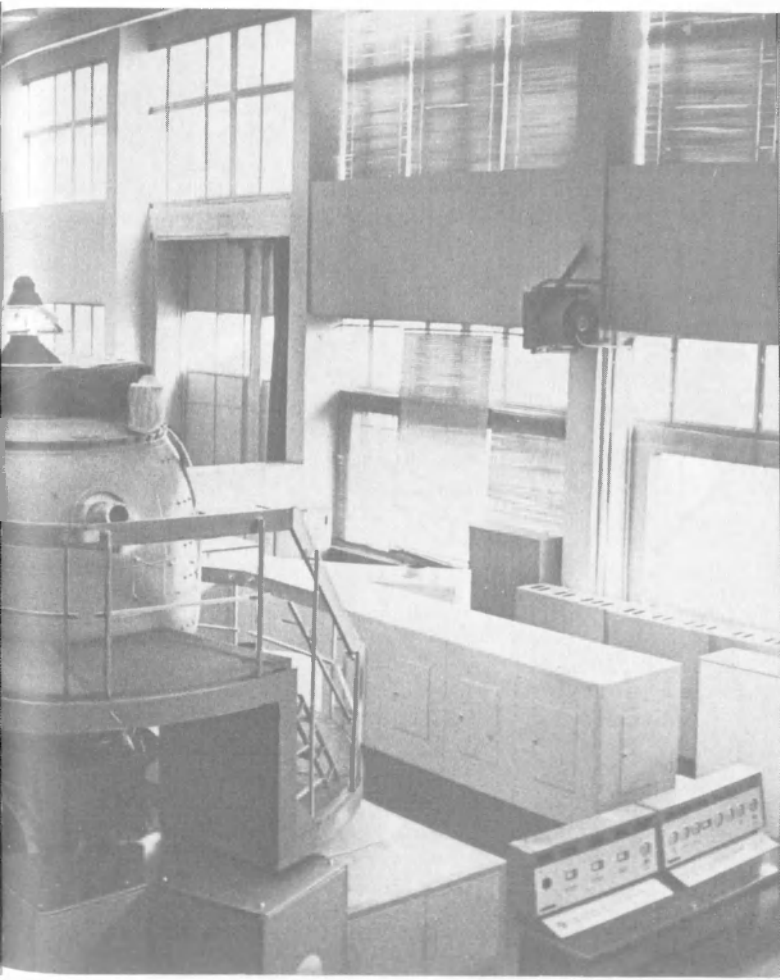
Cosmonaut-pilot of the USSR Vladimir Titov (centre) during the "survival in the tundra" experiment



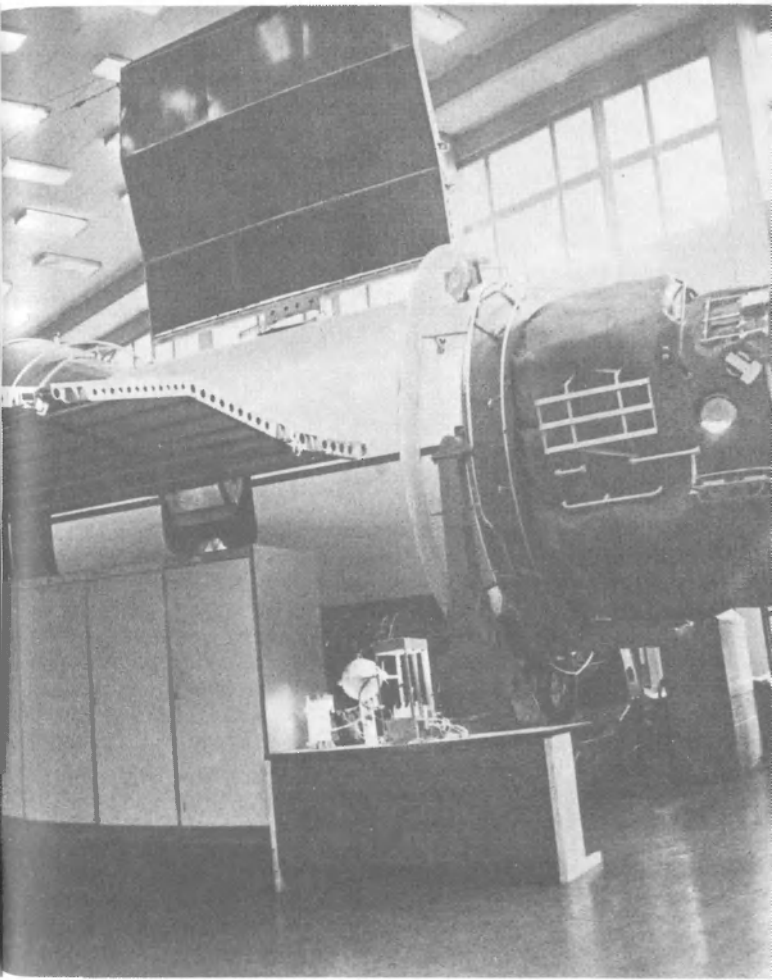


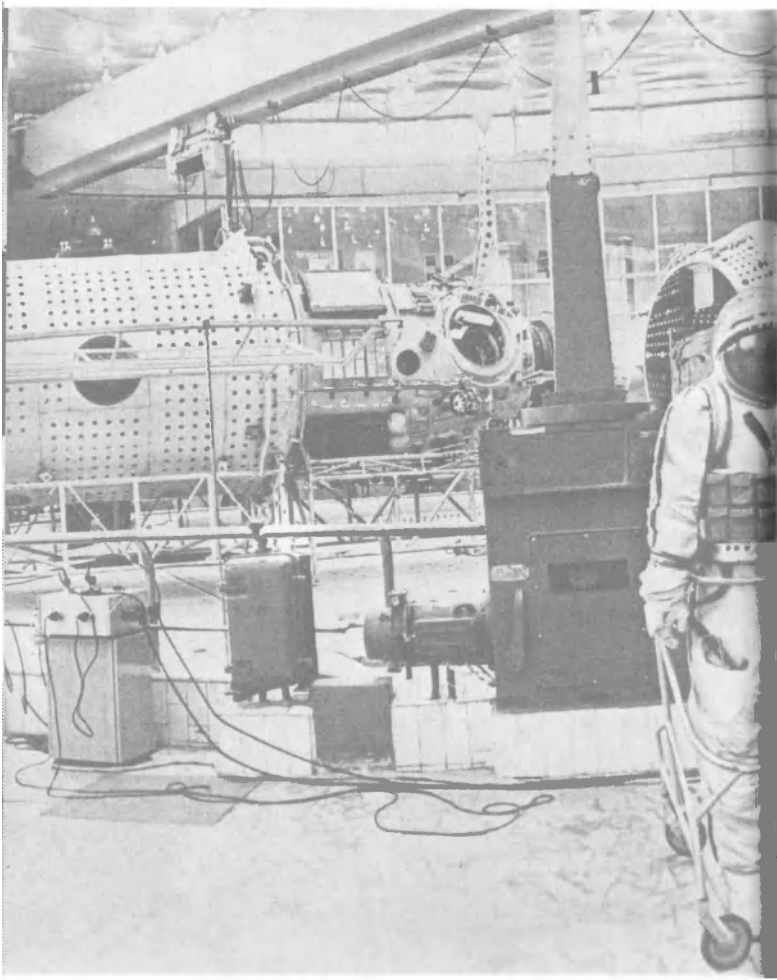


Spaceship simulators

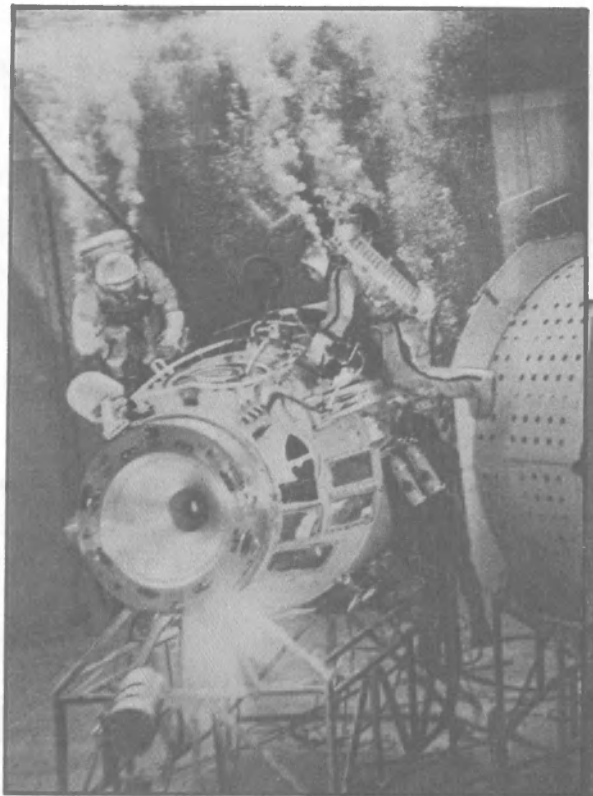


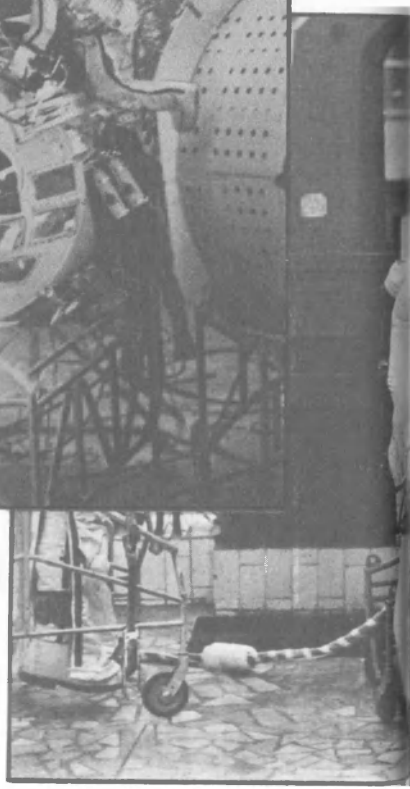
The *Salyut* orbiting station





Preparations for an open space
experiment in the hydro-laboratory





Underwater training in the hydro-laboratory before space flight

The crew of the *Soyuz TM-4* spaceship. Flight engineer Musa Manarov and Commander Vladimir Titov (right) before a routine training session in the hydro-laboratory

Members of the crew of the Soviet-Syrian space expedition, Alexander Viktorenko (left) and Muhammed Faris after landing

The Soviet-Syrian crew (from left to right): Alexander Laveikin, Alexander Viktorenko and Muhammed Faris after landing

Syrian cosmonauts Muhammed Faris (right) and Munir Habib during flight training

Kamanin arrived and dejectedly walked into Kuznetsov's office without lifting his head or looking up. Our new-found hopes were dashed. There was no doubt: the plane had crashed.

Kamanin drove to the airport where he was informed by the launch control centre that a helicopter had spotted a plane wreckage three kilometres from the village of Novoselovo. Nikolai Petrovich stood up, looked around at the men present and said:

"You, you and you come with me." Looking at Kuznetsov he ordered: "You remain here. Get me a helicopter immediately."

All kinds of thoughts came into our heads. Maybe something had happened in the air: the engine failed, sudden icing had occurred, the plane had collided with ... with what? What could a plane run into at an altitude of four thousand metres? But maybe the men had bailed out or made an emergency landing.

Kamanin studied the snow-covered ground below, looking for a parachute or a fire. He recalled how in March 1965 Pavel Belyaev and Aleksei Leonov had made a fire to attract the search planes. But after thoroughly reconnoitering the area, Kamanin could find nothing suspicious. Again our hopes flickered: Gagarin was alive.

Kamanin ordered the pilot to circle one more time. The helicopter flew slowly, at times hovering in the air. Suddenly Kamanin shouted: "Land!" It was the first time he showed any impatience. The helicopter circled and landed about eight hundred metres from the charred ground. Sinking in the snow, Kamanin made his way to the crash site. Standing up to his waist in the snow, he looked around at the thick forest, which undoubtedly had a soft ground covering since the crater was several metres deep but was already being slowly filled with underground water and melted snow.

Aviation specialists with torches and flashlights were combing the site. It was dusk; the temperature was falling. Every new object discovered in the forest was reported to Kamanin, who was searching the crater with professional thoroughness. There could be no doubt that the plane had crashed, but it was unclear what had happened to the pilots. After searching the first few hundred metres nothing had turned up. Again hopes were raised: the men had parachuted from the plane and were alive.

Suddenly the word went round that a pilot's map case had been found. This was distressing news.

After returning to Star City Kamanin called Moscow with information about the first finds. He asked that an emergency commission be formed to include Pavel Popovich and that its first meeting be held as quickly as possible.

The meeting was called for 12.30 a.m.

We saw Kamanin with his lips pressed tightly together, Kuznetsov struggling to control his trembling chin, Leonov with his face to the wall and Popovich repeatedly leafing through flight documents. Each one of these men had all the information available, but no one of them believed Gagarin was dead. The circumstantial evidence pointed to his death, but there was still an absence of irrefutable proof.

Kamanin ordered another helicopter to search the area. The situation was such that no one dared question the rationale for this. People still believed Gagarin might be alive, and they wanted to help save him.

At 23.10, the cosmonauts who had seen and spoken with Gagarin and Seregin on March 26 or 27 were called together. Kuznetsov was the first to speak about the preflight arrangements of the previous day, about Gagarin's readiness, his mood and his plans. He gave a detailed account of Yuri's final hours of

work and mentioned Gagarin's medical check-up, which was completely normal: no problem sleeping, no headaches and no feeling of exhaustion.

The cosmonauts, engineers and various specialists came to tell about their last meetings with Gagarin. Listening to the details of these meetings, it was impossible to believe the tragedy had occurred.

Stepan Sukhinin tried to conceal his emotion as he described the day before Yuri's flight:

"Yuri Alekseyevich carefully wrote down everything said at the preflight training session. He listened to the reports of the navigator on duty and meteorologist, and discussed the upcoming flight with the flight director. He was energetic and happy.

"After Gagarin and Seregin had climbed inside their plane, I went to the launch control centre and listened to the radio transmissions and commands of the flight director. The last radio transmission went, something like this: Yuri Alekseyevich said, 'This is 625. Mission accomplished. Altitude 5,200. Request permission to approach.' The flight director said, 'Check your altitude.' There was no answer. The flight director asked for 625 on all the frequencies. No answer."

Different people related their last meeting with Gagarin. There was nothing unusual or suspicious in their accounts.

It was a tense time. Kamanin never raised his voice to sound more like a commander. He knew that at the first word his requests would be understood and immediately fulfilled. He asked that skiers be thoroughly equipped and sent to the crash site.

Preliminary work was being done at the site. As soon as dawn broke, the search team began to carefully comb the wreckage. Twisted pieces of the plane were removed from the snow, and water pumped out

of the crater. The crater was widened to help make it easier to reach the engine, which was buried deep in the ground.

While looking over the area, Kamanin and the other members of the emergency commission noticed a piece of cloth hanging from a branch about ten metres high. The fragment of material was taken down from the tree and carefully examined. It was the front section of a pilot's jacket. In the pocket meal tickets with Yuri Gagarin's name on them were found. Gagarin was dead.

Kamanin immediately flew to Moscow. A government commission was formed to investigate the circumstances which led to the deaths of Cosmonaut-Pilot of the USSR and Hero of the Soviet Union Colonel Yu. A. Gagarin and Hero of the Soviet Union Colonel-Engineer V. S. Seregin.

That same day, at 21.15 the remains of the two men were cremated. The relatives of the deceased and all the cosmonauts were present.

The second night was endlessly long. In Star City, no one slept. Some sat silently at home, some wandered aimlessly down the streets, some stood in front of Gagarin's sealed office.

On March 29 the Soviet papers announced Gagarin's death to the world.

The *Krasnaya zvezda* (Red Star) printed a letter from the cosmonauts under the caption "His Name Is Immortal":

"We loved Yuri Gagarin. He was our leader, our commander, our conscience. The years we spent together with him in one friendly family of cosmonauts enriched each of us, helped us to become better, more worthy and more broad-minded. He seemed to charge us with his energy. He helped us become public-spirited and good Party members. His experience, his knowledge, his manifold human quali-

ties were available for everyone, for those he was with. We always learned from our Yuri."

The papers printed letters, articles and recollections about Yuri. Vasily Peskov, who knew Yuri well, wrote:

"Gagarin is dear to all of us because the thirty odd years of his life represent a part of our common destiny—a hungry childhood, tattered trousers and lessons by the light of a kerosene lamp; a postwar youth with burning Komsomol passion; a maturity that allows an individual to call himself a communist. Gagarin was our man. This explains the depths of our feelings from the day we first heard his name, and the depth of our grief today when we stand with uncovered heads before a fresh grave."

At nine o'clock in the morning the Red Banner hall of the Central House of the Soviet Army (TsDSA), which contained the urns with the ashes of Yuri Gagarin and Vladimir Seregin, opened its doors to the public.

The line of people who had come to pay their last respects to their hero stretched from TsDSA to Samotechnaya Square. Everyone knew, and they were informed yet again, that the hours were limited. But once the set time period had elapsed, no one left. The government commission extended the hours until midnight.

On March 30 Moscow accompanied the world's first cosmonaut and his comrade on their final journey. The funeral was held at 14.30.

Newspapers all over the world reported the tragedy. The articles, reports and letters reflected pain, suffering and disbelief.

"After crossing all the important thresholds of danger and risk seven years ago, Gagarin returned to us safe. What could happen to him on earth? No doubt many people thought this way, perhaps even

Gagarin himself. And perhaps that is why today there is a sense of guilt: maybe we didn't protect him?

"...You can't shut yourself off from life. A man cannot permit himself to be wrapped in a feather mattress of solicitude, no matter how dear his life is to others. Gagarin more than anything wanted to remain Gagarin. And this had to be taken into account. He flew all the time, trained and spoke of new flights. Was it possible to deny him this?"

The Cosmonauts' Mentor

Today the whole world knows the name of the famous Soviet pilot, one of the first Heroes of the Soviet Union, Nikolai Kamanin. It so happened that I was fortunate enough to serve under him for many years.

During the years of the Great Patriotic War, our squadron was part of a mixed aviation unit under Kamanin's command. As young pilots, we were proud to know we were serving under such a famous pilot. Before the war Nikolai Kamanin had graduated from the military aviation department of the Zhukovsky Air Force Engineering Academy and commanded an aviation brigade and later an entire division. His intelligence, strategic and tactical skills quickly made him one of the Soviet Army's leading commanders.

Kamanin was fearless and had inexhaustible energy and initiative. It seemed like he was never tired; day and night were the same to him. Each time a mission was completed, the General flew to the squadron and with the fastidiousness of an investigator examined the operation. He didn't hand down categorical decisions or consider his opinion infallible. Rather, he listened to anyone engaged in military actions. In our youth we considered this an eccentricity of the thirty-five year-old general.

We were almost always at least partially successful in our missions. But at times this success was bought at a dear price. After studying the flight plan and evaluating the tactics used, Kamanin was rarely satisfied. He thought we were using yesterday's methods. When he was sure of his point of view he would criticize even the most superior officers. We knew of one instance when, after he listened to a report made by Army Commander General Mikhail Gromov, Kamanin addressed the meeting saying he disagreed with the conclusions and analysis of battle casualties and thought that their major cause was the low level of battle training of the commanding officers. With his characteristic resoluteness he refused to countenance banality, conceit and self-aggrandizement.

...Gradually, after passing all the necessary tests, I approached my cherished goal. I didn't achieve everything at once, and my scores were not the highest. My age and rank accorded me no special privileges. After Nikolai Petrovich received the results of the testing and selection, he didn't recommend a softer regimen.

I was happy to have been accepted into the cosmonaut unit. Kamanin congratulated me without emotion and in the future never distinguished me in any way from the other cosmonaut trainees. He was always considerate, composed and taciturn and never gave way to his emotions. His self-control and willpower were admired during those sorrowful days after Gagarin's death, for it was he who had the responsibility of organizing a search of the crash site and then making the funeral arrangements. He answered the questions of Soviet and foreign correspondents, wrote Gagarin's and Seregin's obituaries and suggested ways to immortalize their names. At

the request of Central Television, he spoke to television viewers about the tragedy.

Kamanin made a thorough study of all the documents pertaining to the plane crash, carefully read all the reports and explanations and spoke with anyone who might be able to shed some light on the cause of the accident. With the permission of the individuals he was interviewing, he taped their conversations and later, when alone, carefully listened to it once again.

Maria Kalashnikova, Valentina Gagarina's sister, gave a detailed account of their home life. She recalled that on March 26 she woke up the Gagarin children at 7.00, and while they were washing and getting dressed, she began to prepare breakfast.

Yuri was sleeping. She never woke him up because he always managed to wake up exactly at the time he wanted. That evening he was calm and efficient, as always, and spoke a great deal about Valentina.

That Sunday Valentina came home. Yuri was able to persuade the doctors to let her come home to be with her children. He laughed and said this was treatment, too; home therapy, so to speak.

On March 26 Yuri went to see Valya in the hospital. That entire evening he spoke about her and about his talk with the doctors, and played with the girls. Then he asked for something to eat since he hadn't eaten lunch that day. He asked his sister-in-law if she needed him to do anything around the house, and she gave him some knives to sharpen.

After eating dinner, Yuri put the girls to bed and then went to the garage. He returned home about 10.00 that evening.

These final minutes and hours of his life were now terribly important, and Kamanin hoped that by analyzing them he could discover why the accident had occurred. But no matter how carefully he read

Maria Kalashnikova's account, he could find nothing unusual. Everything seemed normal, as it should have been.

Cosmonautics Day was approaching. As always, representatives from Soviet and foreign radio and television, newspaper and magazine correspondents called Kamanin asking for his advice, material and interviews. He was certainly not in a mood to celebrate, but Cosmonautics Day had become, quite rightly, a national holiday. As only Kamanin could, he hid his pain and received the journalists, telling them about the cosmonauts' achievements and tasks, sharing his plans, recommending stories and pictures and setting up meetings with cosmonauts. He was approached with requests for advice and assistance, and as busy as he was with his own duties and responsibilities, he never refused. He read articles, corrected essays and suggested new outlines for books. In other words, he splendidly fulfilled his duty.

In an article entitled "Daring", Kamanin wrote:

"The road to the stars is difficult and rigorous. We have lost two talented testers of spacecraft along this road—Yuri Gagarin and Vladimir Komarov. Their feats are immortal. They did not accomplish them for the sake of glory or a comfortable life, or so that people would repeat their names. They moved forward along that untravelled road because their nation, all the people on earth, science and progress, required it...

"In our minds we realize that when mankind steps into a new, unknown region, when daring exploration of the universe is being undertaken, fatalities are possible. But it is difficult to accept this in our hearts.

"But life goes on. The Soviet people will inevitably move on and discover the unknown for the good of mankind. This was the way it was and the way it will be."

On the eve of Cosmonautics Day, General Kamanin called me into his office. He asked me about my training and how the men in the unit were getting along. Then he began to speak about Gagarin:

"You know, Georgi Timofeyevich, how much time I spent with Yuri Alekseyevich. We just about travelled the world over, visiting all the largest countries. All our trips were successful.

"Yuri generally spoke 18-20 times a day and gave interviews. No doubt this required an enormous amount of effort. When he got back to the car, he would fall into my arms half-dead and go to sleep. I was happy then, both because a world-famous man was sleeping as quietly as a child in my arms and also because he trusted me and drew strength from our contact.

"We were able to work so efficiently due to good organization and strict discipline..."

Kamanin continued to speak about Yuri, about his tremendous authority, world popularity, and the desire of all types of people, regardless of position or age, to meet him. Then he told me about preparations for the launching of the *Soyuz* spacecraft and the *Luna-14* space probe which would soon be in orbit around the moon.

"I won't be flying with you," Nikolai Petrovich said softly. "For the first time I won't be with you at the cosmodrome." He was silent for a long time, perhaps thinking once again about Gagarin. "A group will be formed and you will be put in charge. And one more thing: don't refuse to fly. You must test the *Soyuz* as soon as possible."

I stood and answered in military fashion: "Yes sir!"

A day later we flew to Baikonur.

Time passed, and those sorrowful days following Gagarin's death faded into the past. Still, whether we were training, watching a space launch at Baikonur or trying on new spacesuits, we thought about Yuri and measured our efforts against the standards he had set.

We were asked to speak and write about him, but we couldn't. The pain was still too great. Newspapers and magazines continued to publish the articles Gagarin had written, the interviews he had given and the book introductions he had composed at the request of the authors. The magazine *Aviatsiya i kosmonavtika* (Aviation and Cosmonautics) printed his article "Our Country's Road to Space" in which he stated:

"Many people abroad who have been surprised by the Soviet Union's leadership in space exploration have come to realize that the launch of the first satellite and then the first manned orbital flight were by no means accidental or isolated achievements. They were the logical result of the development of socialist society, a result reflecting the great constructive forces, economic might and tremendous creative potential of our Motherland."

The world deeply respected the memory of the first cosmonaut. Cities, villages, streets, boats, scientific institutes, even children were named after him. A museum was opened in his honour, statues erected, memorial plaques and medals inscribed and festivals organized in his name. Pavel Barashev, a journalist, wrote an article about him entitled "Son of Earth". Some time later Nikolai Kamanin repeated: "Son of Earth! That is the best description of Yuri. He was the first to penetrate space and safely return to earth. Mankind has deemed this feat immortal."

But this was later, much later. At first we didn't

write about Gagarin, for no one could come to speak of him in the past tense or describe that which we could not yet totally comprehend.

Gagarin himself had tried his hand at writing. His style was clear and concise, and he was eloquent in his descriptions of the cosmonauts and their work. He wanted to write a number of books about his profession and his friends, like Gherman Titov, Pavel Popovich, and Valery Bykovsky, and he left notes and outlines for numerous articles which were never completed.

The first to write about Yuri Gagarin was Gherman Titov:

"Yuri left us all too soon. This man could have accomplished vastly more for the space programme than he did; he had only started down the great road of his profession. The age has lost its hero. It was an unexpected loss, and our grief, the grief of all the people of the world, was truly boundless. People from all corners of the globe paid tribute to the man of the universe, the man who fulfilled their dreams with his heroic deed, who demonstrated on our behalf before the history of civilization what we had achieved in our development, revealing that the thoughts and deeds of the world's scientists from ancient times up to the present had been realized—108 minutes of space flight; one orbit around the planet Earth!"

Andrian Nikolayev later wrote:

"He always said what he thought, what he deeply believed in. All of us who were in Yuri's unit recall how he gained in confidence before our eyes. Each year his talent grew as a thoughtful, strong-willed commander and organizer, a wonderful psychologist and remarkable comrade. Yuri combined a commander's exactingness with responsiveness and warmth."

The missions were becoming increasingly more

complex, the orbits and interplanetary routes—more distant. In the years following Gagarin's death, dozens of Soviet cosmonauts flew into space, and a number of interplanetary probes were launched, including the Luna, Venus and Mars projects. All these new achievements in space exploration we dedicated to Gagarin's memory.

Vitaly Sevastyanov met Yuri Gagarin in 1960 and watched him become Cosmonaut Gagarin:

"Yuri was one of those people who seem to be born for society, who do social good as naturally as breathing and moving. He was an exceptionally good person. In my opinion, this was his most important character trait. He was concerned about everything: if it was a small group of people, just friends, he was attentive to everyone; if it was a work collective, like his cosmonaut unit, he showed concern for each cosmonaut; if it was our entire society, he served it as a true citizen, a true public figure.

"Yet I must emphasize that, first impression to the contrary, Yuri was not an easy person to understand. He was very complicated, complicated in a good way. Like a sponge, he drank in everything that was good. And this ceaseless accumulation of spiritual values and knowledge seemed to occur without effort. Each time we met I became more convinced of how well he understood the operation of many spacecraft. He grew before my eyes, and this happened at a time when he was continuously working, when he could easily not have had the time to increase his knowledge or worry about spiritual values.

"One other thing I'd like to add: Yuri carried the burden of fame remarkably well. Though he had many opportunities, he never did anything to increase his fame."

Valery Bykovsky went through the cosmonaut recruitment process with Gagarin and was one of the

six trainees the journalists justifiably called "Gagarin's detachment". Bykovsky wrote:

"Much has already been written about Yuri Gagarin, and grateful people will continue to write about him. To those of us who knew him well, it often seems that writers about Gagarin try to emphasize the spectacular about this remarkable man. But Yuri Gagarin was, above all, a good worker—inquisitive and stubborn, avid in his desire to understand the world, a worthy son of his people."

Yevgeni Khrunov, a happy-go-lucky energetic fellow who was known to his friends as the "walking computer", wrote that Gagarin had become a legend in his own time, a symbol of what man was capable of. "I consider it my duty to say that Gagarin should never be depicted as a dashing fellow with a perpetual smile on his face. It is true, he loved life and people; he knew how to have a great time and was incredibly sensitive. But in his work—and this played a large, important role in his life—he was unusually concentrated and when necessary—exacting and strict, both to himself and others. So to always be talking about his smile is to cheapen his image."

Understanding the unquenchable interest in Gagarin, many authors began to write about him. We cautioned against their being too hasty and writing without sufficient information, but our advice was not heeded. These literary experiments were not successful and remained unfinished.

Those of us who knew Gagarin well, who had seen him at work everyday, who felt his irresistible influence, quailed before the greatness of his name. His self-control, discipline, remarkable industriousness, optimism, intelligence and purposefulness were those qualities which made him a recognized leader.

Yuri never tried to impress anyone with his know-

ledge or authority, and he was never afraid to speak the truth. Without subterfuge, he would admit he hadn't read a book, though he very much wanted to, that he hadn't seen a performance, even though he had been invited to the premiere, that he hadn't been to an exhibition of the works of a well-known artist, though he had been asked to attend the opening.

It was interesting to work and train with him. Despite his youth, he had acquired a great deal of experience, the kind of wisdom which allowed him to avoid friction in his work group and conflicts with his comrades.

I don't by any means wish to idealize Gagarin, but these are the character traits which determined his authority. He was incredibly busy, but never fussy; he was engaged in important professional and social affairs, but he never turned away from a friend; he was capable of doing many things, but he never used his abilities for personal gain.

Gagarin dreamed of the time when an international crew would fly in space. When travelling abroad, he often spoke of this and urged all the countries of the world to join in a more thorough and better planned programme of space exploration. In the spring of 1968 he was preparing to address a UN conference on the research and utilization of space for peaceful purposes. His tragic death prevented him from making his speech. Among the questions he wished the conference to consider was international cooperation in space exploration, the launching of an international crew and changing the name of the Soviet Cosmonaut Training Centre to the International Cosmonaut Training Centre.

In 1973 the Gagarin Cosmonaut Training Centre became an international centre. American astronauts came here to train. In 1976 future cosmonauts from the socialist countries arrived. The Communist Party

tion about the first cosmonaut.

After his orbital flight, cosmonaut Sigmund Jähn of the GDR remarked:

"We have become accustomed to new lift-offs, orbital dockings and space laboratories. Today this all seems routine. Still, after centuries and millennia have passed, man will never forget the name of the resident of the planet who freed himself of the earth's gravitational pull and for the first time looked down upon our planet. It was Gagarin who called it the 'blue planet', and we still use that term today. While I was in space I remembered Gagarin's words about the beauty of the earth. Our most important concern right now is to do everything possible to preserve the earthly beauty of our blue planet, improve the people's lives and free them of the threat of atomic destruction."

Gagarin had proposed building a museum in Star City, and this was finally done. The museum is unique, and the exhibits reflect this. Rather than provide information about the history of the Soviet space programme and the creative efforts of space engineers and scientists, the museum reflects the life of Star City, particularly the practical activities of the cosmonauts. There are also many exhibits dedicated to the Gagarin Cosmonaut Training Centre's many international contacts.

The USSR's leading role in space exploration is reflected in many exhibits, and the gifts presented to the museum by foreign and Soviet work collectives and leaders of states and governments have become unique items of world history.

Long before the 20th anniversary of Gagarin's flight, articles appeared in the press about its lasting significance and tremendous contribution to world civilization. Georgi Ivanov, a Bulgarian cosmonaut wrote:

"I will always consider Gagarin a legendary figure, a living example beckoning us to the future. On a visit to our country Yuri Alekseyevich remarked that soon Bulgaria would travel into space. I am exceedingly proud of my country, proud that these prophetic words spoken by the world's first cosmonaut came true."

Gagarin headed the Soviet-Cuban Friendship Society. He had a number of friends in Cuba and expressed a great deal of interest in the work and revolutionary life of this friendly country. It was his dream one day to travel into space together with a Cuban cosmonaut. Some time after his death, Cuban cosmonaut Arnaldo Mendez spent several days aboard an orbiting space station conducting scientific research. After he returned to earth, Mendez said:

"When Yuri Gagarin visited Cuba in 1961, he said that the time would come when a Cuban would fly into space. His words were prophetic. Seventeen years later, in March 1978, I came to the Soviet Union to begin training for a space flight together with my friend José Lopez.

"We were very impressed with the Gagarin Cosmonaut Training Centre. It had the best technological equipment, and the people who met us there and became our friends were attentive and helpful. The language was difficult for us at first. But teachers, instructors and our cosmonaut friends, and our active involvement with them during lessons, training sessions and relaxation soon helped overcome this difficulty.

"...Gagarin's courage, his confidence in success of the flight and his winning smile were with me at the Cosmonaut Training Centre and during the joint flight aboard the orbital complex."

As told by Yevgeniya Malakhovskaya

"PIONEERS OF SPACE" IS A COLLECTION OF DOCUMENTARY ESSAYS WRITTEN BY COSMONAUTS, SCIENTISTS AND JOURNALISTS ABOUT THE ORGANISATION OF THE SOVIET SPACE PROGRAMME. IT OFFERS INFORMATION ABOUT THE ESTABLISHMENT OF THE COSMONAUT TRAINING CENTRE, THE DIFFICULTIES THAT SOVIET SCIENTISTS, ENGINEERS, PHYSICIANS AND RESEARCHERS FACED IN PREPARING FOR THE FIRST SPACE LAUNCH, AND DESCRIBES THE CHARACTER OF THE WORLD'S FIRST COSMONAUT – YURI GAGARIN.

THE BOOK SHOWS THE PEACEFUL NATURE OF THE SOVIET SPACE PROGRAMME AND DISCUSSES EXCITING MYSTERIES OF THE UNIVERSE AND THE POSSIBILITY OF THE EXISTENCE OF LIFE ON OTHER PLANETS.

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